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Radiological Survey and Evaluation of the Fallout Area from the Trinity Test:

Chupadera Mesa and White Sands Missile Range, New Mexico

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Preface

This series of reports results from a program initiated in 1974 by the Atomic Energy Commission (AEC) for determination of the condition of sites formerly utilized by the Manhattan Engineer District (MED) and the AEC for work involving the handling of radioactive materials. Since the early 1940s, the control of over 100 sites that were no longer required for nuclear programs has been returned to private industry or the public for unrestricted use. A search of MED and AEC records indicated that for some of these sites, documentation was insufficient to determine whether or not the decontamination work done at the time nuclear activities ceased is adequate by current guidelines.

This report contains data and information on the resurvey effort and the effect of residual contamination as a result of nuclear weapons development programs conducted in this area. The report documents the present radiological conditions within the realm of today's sophisticated instrumentation and the impact on any future area development.

This report was prepared by the Environmental Surveillance Group (HSE-8), Health, Safety and Environment Division of Los Alamos National Laboratory. This report was compiled and written by Wayne R. Hansen and John C. Rodgers with major contributions from William D. Purtymun, Donald M. Van Etten, John D. Purson and Kenneth H. Rea. Field work in 1977 was directed by Daniel W. Wilson. Field *in situ* measurements and laboratory sample counting were directed by John Kirby and Douglas Sever of Lawrence Livermore National Laboratory. Other Los Alamos personnel involved in measurements were Thomas E. Hakonson, John W. Nyhan, Edward Rahrig, Thomas E. Buhl, and Alan K. Stoker.

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by

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ABSTRACT

Current radiological conditions were evaluated for the site of the first nuclear weapons test, the Trinity test, and the associated fallout zone. The test, located on White Sands Missile Range, was conducted as part of the research with nuclear materials for the World War II Manhattan Engineer District atomic bomb project. Some residual radioactivity attributable to the test was found in the soils of Ground Zero on White Sands Missile Range and the areas that received fallout from the test. The study considered relevant information including historical records, environmental data extending back to the 1940s, and new data acquired by field sampling and measurements. Potential exposures to radiation were evaluated for current land uses. Maximum estimated doses on Chupadera Mesa and other uncontrolled areas are less than 3% of the DOE Radiation Protection Standards (RPSs). Radiation exposures during public visits to the U.S. Army-controlled Ground Zero area are less than 1 mrem per annual visit or less than 0.2% of the RPS for a member of the public. Detailed data and interpretations are provided in appendixes.

1. SUMMARY

This evaluation of current conditions at the site of the first nuclear weapon test (Trinity) and the associated fallout areas is based on extensive field measurements and sampling followed by interpretation of the resulting data. The study was completed as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP) sponsored by the U.S. Department of Energy (DOE).

The Trinity test was part of the research conducted for the World War II Manhattan Engineer District (MED) atomic bomb project. The test was conducted on July 16, 1945. Measurements of radiation levels at Ground Zero (GZ) and in the fallout zone began the same day. The fallout was blown in a northeast direction over White Sands Missile Range, Chupadera Mesa, and other ranching areas. The land uses in the fallout zone remain the same today. White Sands Missile Range extends north of GZ about 17 km (10 miles). Privately owned ranch land extends along the path of the fallout zone to the northeast with Chupadera Mesa areas of interest at about 50 km (30 miles) northeast of GZ. Land use on Chupadera Mesa is for cattle grazing. Areas farther out in the fallout area also are used for cattle grazing with small areas of crop production.

This study considered all available relevant information. Records and reports provided the history of the measurements of radiation and radioactivity at GZ and the fallout zone. Environmental measurements and sample results, some extending back to the 1940s, were reviewed for information on trends and patterns. Data from these and special radioecology research studies were compiled to provide a basis for planning the acquisition of new data. Most of the new data consist of several hundred field measurements and samples of soil and vegetation.

The findings, based on interpretation of the data, are expressed in this summary as maximum increments of risk to hypothetical individuals exposed to the existing conditions. Individual risks of cancer from exposure to radiation were calculated from factors derived from the National Academy of Sciences 1980 study. Potential exposures to radiation for various possible mechanisms were generally calculated as 50-year committed dose equivalents resulting from 1-year exposures to account for cumulative doses from those radioactive materials retained in the body for varying periods after initial exposure. Exposure to natural background results in exactly the same kind of risks. The risk-estimating factors were applied to natural background radiation as measured in north central New Mexico to provide one context for judging the significance of other risks. People living in northern New Mexico incur an estimated incremental risk of cancer mortality of 8 chances in 10 000, or a probability of 8×10^{-4}, from a 50-year exposure to the natural radiation background. The natural radiation background dose, about 150 mrem each year, includes contributions from cosmic radiation, natural terrestrial radioactivity, and natural radioactivity incorporated in the body. A larger perspective is that the overall U.S. population lifetime risk of mortality from cancers induced by all causes is currently about 2 chances in 10, or a probability of 0.2.

The maximum likely incremental risks from all mechanisms of potential exposure in the areas having residual radioactivity attributable to the residual radioactivity range from about 2 chances in 10 000 (2×10^{-4}) in the restricted use area to a minimum of 6 chances in 10 000 000 000 (6×10^{-10}) under current conditions of land use as summarized in Table I. The mechanisms include direct exposure to penetrating radiation and inhalation of resuspended dust.

Table I gives the incremental risks of cancer mortality, bone cancer, and lung cancer, along with the 50-year dose commitments from which they were calculated. All of the dose commitment values are considered overstated to some degree because assumptions used in their derivation were made to maximize estimates of potential effects. All of the dose commitments are small fractions of those permitted above natural background and medical exposure by the DOE Radiation Protection Standards (RPSs). Maximum estimated doses on Chupadera Mesa and other uncontrolled areas are less than 3% of the RPSs.

Another context for judging the significance of these risks associated with exposure to radiation, whether from

natural background or other sources, is a comparison with risks from other activities or hazards encountered in routine experience. Table II presents a sampling of risks for activities that may result in early mortality and annual risks of death from accidents or natural phenomena. Because not all of the risks are directly comparable, the values for mortality risks shown in Table I overlap the range of values for risks shown in Table II. The largest incremental risks from the exposure to the residual contamination are about the same size as the incremental risk of a 1000-mile automobile trip; most are smaller than the annual risk of death from lightning.

Some differences in future conditions will result from radioactive decay processes. While the total doses from transuranium elements will not change appreciably, the doses from ^{90}Sr and ^{137}Cs will decrease 50% in about 30 years. At the GZ area the external radiation doses will decrease about 90% in the same 30 year period.

TABLE I

ESTIMATES OF RISK BASED ON EXPOSURES ATTRIBUTABLE TO RESIDUAL CONTAMINATION IN AREAS OF FALLOUT FROM THE TRINITY TEST[a]

Location[b]/Exposure Hypothetical Resident	Incremental Risk: Increased Probability Based on 50 Year Committed Doses[c]				Committed Dose: mrem in 50 years from 1 Year Occupancy				
	Overall Cancer Mortality	Bone Cancer	Lung Cancer	Liver Cancer	External Whole Body	Body	Bone	Lung	Liver
GZ									
Inner fence	2.0×10^{-4}	2.2×10^{-7}	1.4×10^{-7}	1.1×10^{-6}	1700	2.5	75	1.5	36
Between fences	1.1×10^{-4}	8.7×10^{-9}	2.3×10^{-8}	4.2×10^{-8}	880	0.17	2.9	0.26	1.4
White Sands Missile Range	1.9×10^{-5}	6.3×10^{-8}	8.7×10^{-8}	1.0×10^{-7}	14	1.8	21	0.97	3.4
Bingham	4.0×10^{-7}	5.7×10^{-8}	4.2×10^{-8}	7.5×10^{-8}	1.7	1.6	19	0.47	2.5
Chupadera Mesa	1.8×10^{-6}	1.2×10^{-7}	1.6×10^{-7}	2.7×10^{-7}	13	2.1	39	1.8	9.0
Far Fallout Zone	7.4×10^{-7}	4.8×10^{-8}	3.1×10^{-8}	3.6×10^{-8}	5	1.2	16	0.34	1.2
San Antonio	2.2×10^{-7}	6.0×10^{-10}	1.8×10^{-8}	1.5×10^{-9}	1.7	0.1	0.2	0.2	0.05
Other Hypothetical Exposures									
40 h of Work in GZ inner fenced area	9.6×10^{-7}				8				
Security Patrols	9.0×10^{-8}				0.75				
Annual visitor at Open House of Trinity Site	1.2×10^{-7}				1.0				
Natural Radiation Exposure, Los Alamos									
1 year occupancy	1.6×10^{-4}				134				
50 year occupancy	8.0×10^{-4}				6700				
Radiation Protection Standard					500	500	1500	1500	1500

[a] All calculations based on current conditions.

[b] Locations are described in more detail in Chapter 4.

[c] Probabilities are expressed in exponential notation; they can be converted to expressions of chance by taking the numerical value in front of the multiplication sign (×) as "chances" and writing a one (1) followed by the number of zeros given in the exponent. For example, 9.7×10^{-7} becomes 9.7 chances in 10 000 000.

TABLE II

RISK COMPARISON DATA

Individual Increased Chance of Death
Caused by Selected Activities

Activity	Increase in Chance of Death
Smoking 1 pack of cigarettes (cancer, heart disease)	1.5×10^{-5}
Drinking 1/2 liter of wine (cirrhosis of the liver)	1×10^{-6}
Chest x-ray in good hospital (cancer)	1×10^{-6}
Travelling 10 miles by bicycle (accident)	1×10^{-6}
Travelling 1000 miles by car (accident)	3×10^{-6}
Travelling 3000 miles by jet (accident, cancer)	3.5×10^{-6}
Eating 10 tablespoons of peanut butter (liver cancer)	2×10^{-7}
Eating 10 charcoal broiled steaks (cancer)	1×10^{-7}

U.S. Average Individual Risk of Death in One Year
Due to Selected Causes

Cause	Annual Risk of Death
Motor Vehicle Accident	2.5×10^{-4}
Accidental Fall	1×10^{-4}
Fires	4×10^{-5}
Drowning	3×10^{-5}
Air Travel	1×10^{-5}
Electrocution	6×10^{-6}
Lightning	5×10^{-7}
Tornadoes	4×10^{-7}

U.S. Population Lifetime Cancer Risk

Contracting Cancer from All Causes	0.25
Mortality from Cancer	0.20

2. INTRODUCTION AND BACKGROUND

I. THE DOE RESURVEY PROGRAM

The 1977 and 1983 survey of the Trinity Site was carried out as part of the DOE program aimed at formulation of any remedial actions for Manhattan Engineer District (MED) or Atomic Energy Commission (AEC) sites. In the DOE program, files were reviewed to determine if residual radioactive contamination might exist at the sites. If the radiological conditions were uncertain, a survey of the area influenced by the site was performed. The files and special studies in existence for the Trinity Site indicated a survey would be necessary to quantify the radiological condition of the 32-year-old fallout area from the first nuclear explosion at White Sands Missile Range in New Mexico, July 16, 1945.

Several studies of the fallout zone had been carried out before the resurvey. These included surveys immediately after the test in 1945, studies by University of California, Los Angeles (UCLA) in 1948, 1950, and 1951. In 1973 and 1974, the U.S. Environmental Protection Agency (EPA) carried out an extensive soil sampling program for plutonium in the area. The study included air samplers located on Chupadera Mesa and in Socorro, New Mexico. Starting in 1972 and continuing until 1979, Los Alamos Scientific Laboratory, conducted special ecological studies of the movement of ^{137}Cs and plutonium isotopes on study plots on Chupadera Mesa and near Ground Zero (GZ) located on White Sands Missile Range. Factors influencing the survey were the history of the Trinity test, previous studies of the fallout zone, and the stated objectives of the Formerly Utilized Sites Remedial Action Program. Each of these factors is discussed in more detail in following paragraphs. Separate chapters are devoted to the resurvey plan, the results, and interpretation of the data. Appendixes are included that contain the historic data base, the raw data from this study, a log containing locations of sample locations, calibration methods for the *in situ* detector system used, and calculational methods used for estimations of radiation dose equivalents from any residual fallout radionuclides.

II. THE TRINITY TEST

The Trinity test of the first atomic bomb took place on July 16, 1945, on White Sands Missile Range in Central New Mexico. The test resulted in deposition and dispersal of radioactive fallout over a portion of central and northeastern New Mexico. Figure 1 is a map of the general area with Trinity Site marked on the lower left-hand corner of the map. The device was mounted on a 100-foot tower with cables for instruments and timing strung to shelters 9144 m (10 000 yds) away. Figure 2 is a photograph of the tower-mounted device before the test. The Oscura Mountains are in the background of the photograph about 5 miles east of the test area.

Weather on the day of the test started out being cloudy and windy with scattered showers. At 2:00 a.m., the test was rescheduled from 4:00 a.m. to 5:30 a.m. At 4:00 a.m., the rain stopped and at 4:45 a.m., a favorable weather forecast indicated the 5:30 a.m. time was acceptable. Weather remained cloudy after the test, as observed by planes sent to drop sensors during and after the test.[1] After the test, a crater and zone of melted sand were created (Fig. 3). The green fused sand is referred to as Trinitite in many reports. The GZ area has been designated a National Monument. As noted earlier, GZ is located on White Sands Missile Range, and access is controlled throughout the year. Once annually, the public is invited for a controlled visit to the site, usually in the month of October. Figure 4 is a diagram of the GZ fenced area included in the public visits.

III. THE TRINITY FALLOUT ZONE

Following the test, measurements were made to establish the trajectory of the fallout cloud and the deposition pattern over Chupadera Mesa and areas northeast of GZ. Measurements during 1945 were made across the fallout pattern to outermost edges of the fallout zone.

Figure 5 is a depiction of the fallout zone based on beta-gamma surveys of the soil surface following the test. The fallout followed a northeasterly direction paralleling

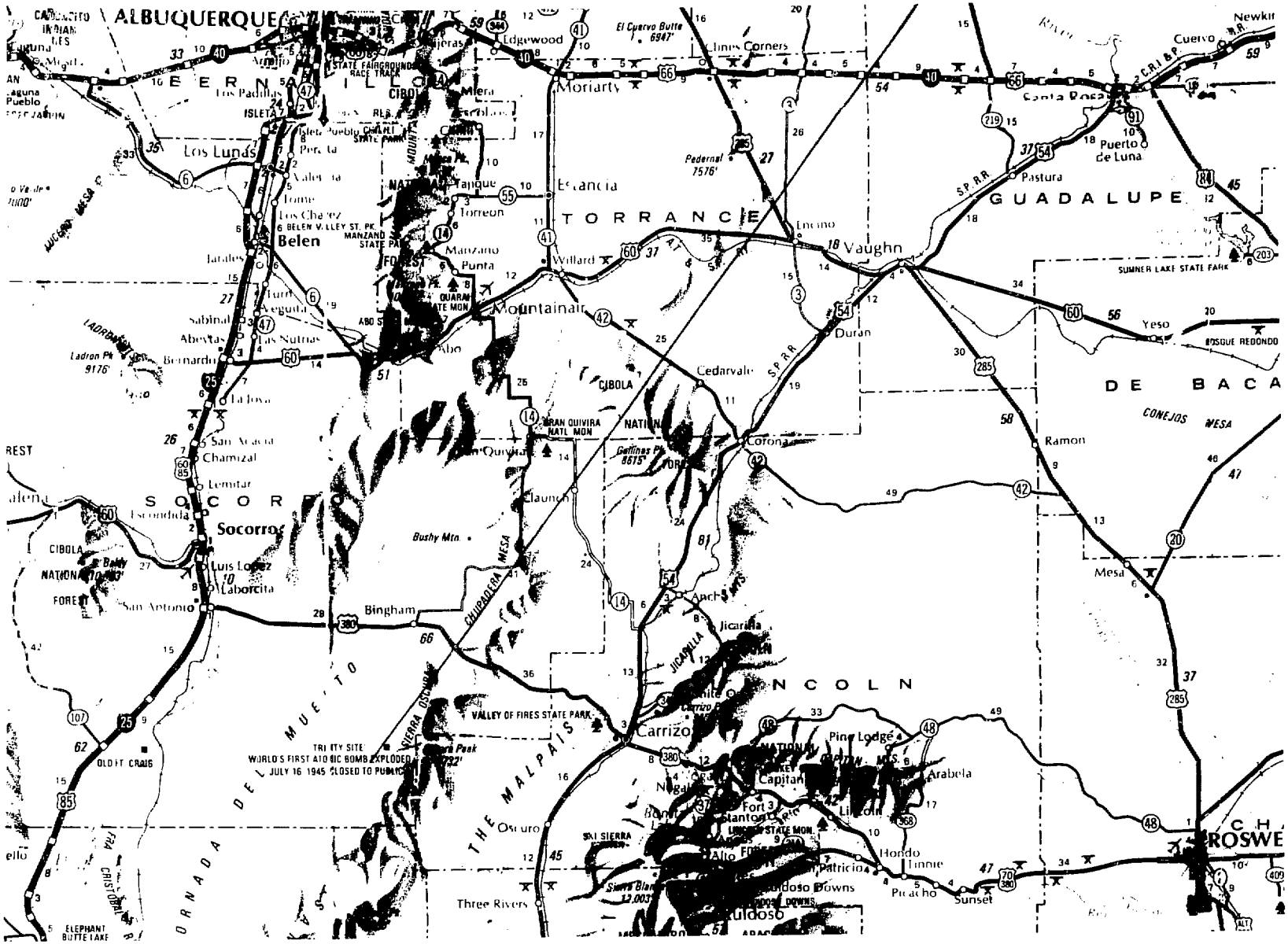

Fig. 1. Central New Mexico. The site of the Trinity Test is noted on the lower left part of the map.

Fig. 2. Trinity test tower. Oscura Mountains in the background.

the west of U.S. Highway 54 (Fig. 1). The cloud passed over Chupadera Mesa, where localized areas of higher levels were observed.

Another beta-gamma survey carried out in 1947 and 1948 confirmed the earlier observations and added detail to the mapping of the area.[2] Figure 6 is an outline map of the contaminated area taken from the 1947 and 1948 studies.[2] A primary transect reference line was established in the 1947 study. The transect of 34° 56' started at the Section Marker at GZ. At every 4930 feet, reference points were marked for the first 11 points. At point 12, the reference points were marked every 9000 feet. From this primary transect, reference line laterals were extended 90° right and left. Sampling and study areas were established according to the lateral numbers. For example, an area of special study on Chupadera Mesa at lateral 21 (about 28 miles from GZ) is referred to as area 21. This type of designation is referred to in reports of several studies of the Trinity fallout zone.

Since 1945, radioactive decay has resulted in substantial reductions of the fallout levels so that only the long-lived radionuclides ^{90}Sr, ^{137}Cs, and ^{239}Pu with traces of europium, remain. In the intervening years, environmental and biological transport processes such as erosion, sedimentation, and biotic uptake have acted on the initial surface deposition to redistribute these long-lived radionuclides. A number of studies were carried out to characterize the radionuclide distribution and redistribution in the years following the test.

The first major studies were carried out between 1947 and 1950. These studies emphasized radionuclide concentrations including plutonium for soils and plants, particularly on Chupadera Mesa, the crater region, and the region north of the crater, but still on White Sands Missile Range,[3,4] The studies included characterization in the soils and plants of the area.

Plant studies included a study of the revegetation of GZ. Studies were also carried out that involved descriptions of the movement of small mammals, reptiles, and birds in the area surrounding GZ.[5] The results of these studies have been included in considerations of the design of this study.

In summary, elevated levels of plutonium and fission products were measured in the fallout pattern. The maximum concentrations in soil outside the fenced area of GZ were detected on Chupadera Mesa about 28 miles from GZ. The authors suggest a localized rain shower may have scrubbed a portion of the fallout cloud.[4] During the study period of 1947 to 1950, there also was observed some downward migration of fission products in the soil. However, wind erosion in the crater area of GZ was relatively more important than water in spreading the contamination.[6] Plutonium was found in amounts up to 19 pCi per square foot at area 21. No plutonium was found in samples collected 3 miles south of GZ.[7] Studies of plant invasion of the crater area through 1964 concluded that, while the area had not returned to climax vegetation, distributional patterns were controlled by water availability, soil conditions, and timing of climatic variants rather than radiation.[8]

Fig. 3. Range after test.

In 1972, a series of special studies of the plutonium distribution were started by Los Alamos Scientific Laboratory. Soil, vegetation, and rodent samples along the fallout transect were obtained at GZ and out to 56.4 km (35 miles).[9] Soil samples from GZ indicated a relatively uniform vertical distribution of plutonium in the 30-cm-deep soil samples. Increased migration of plutonium into the soil was observed. Concentrations of plutonium in vegetation and rodents were too low to make valid comparisons. From the data taken, four intensive study areas were established at 1.6 km, 16 km, and 44 km, in addition to a control site south of GZ.[10] About half of the $^{239,240}Pu$ in the Trinity fallout zone soils was found at the 5- to 20-cm depth in 1973 compared with total plutonium inventories being detected only in the upper 5 cm of soil in previous studies (21 to 25 years). Penetration depths of $^{239,240}Pu$ into the fallout zone soils were related to the presence of subsoil horizons containing carbonate accumulations and to the extent of rainwater penetration into the soil profiles.[10,11] Studies of plutonium as related to concentrations on vegetation indicate concentration ratios as high as 1.0 for dry weights.[12] The range for forbs was 0.04 to 1.1 and grasses 0.05 to 1.2. Contamination of plant surfaces with soil particles is considered the cause of plant-soil ratios higher than observed in greenhouse studies.

In 1973 and 1974, the EPA sampled and analyzed soils from across the region of the Trinity fallout field for ^{239}Pu and ^{240}Pu in the top 5 cm of the surface soil.[13] Before publication, the results of the survey and the field notes from the sampling were forwarded to Los Alamos by the EPA. The highest surface plutonium level was observed on the White Sands Missile Range. The GZ sample contained 1100 nCi of $^{239,240}Pu$ per square meter of soil surface. A soil sample taken approximately 3.2 km (2 miles) north of GZ contained 100 nCi per square meter, but neighboring sample locations gave plutonium value factors of 4 to 10 times lower.

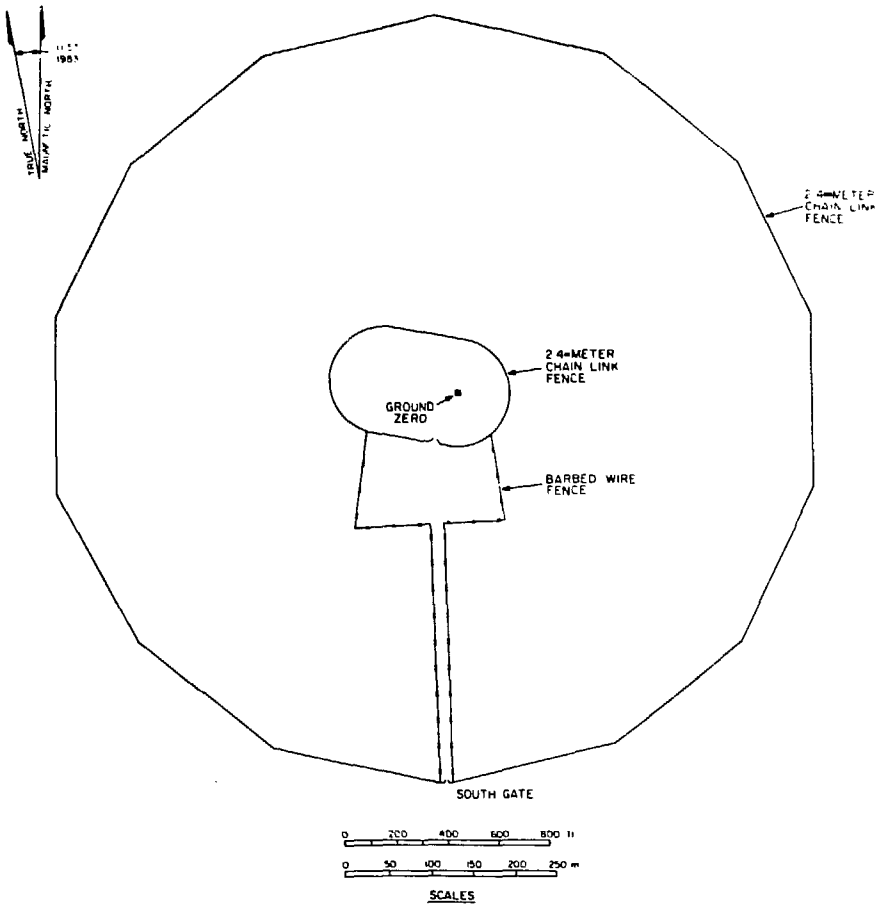

Fig. 4. Diagram of Trinity GZ fences.

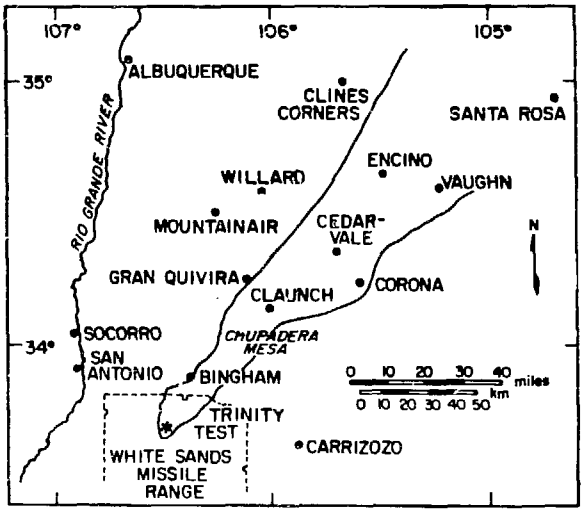

Fig. 5. The fallout zone from the Trinity test as determined by a 1945 beta-gamma survey.

Consistent with earlier findings of the initial fallout distribution, plutonium levels generally decrease with distance from GZ and with lateral distance from the centerline. The increase on Chupadera Mesa, some 20 to 30 miles from GZ, is also observed in the data. The highest level reported by EPA on the mesa at a single location was 86 nCi per square meter. Background values, that is, the minimum values, were reported at less than 1 nCi per square meter.

The EPA study also included carrying out air sampling for airborne plutonium. An air-sampling station was established at Socorro, New Mexico, and another air-sampling station was established at Monte Puerto Ranch on Chupadera Mesa. Air samples were collected over a 10-month period. The samples were analyzed for ^{239,240,238}Pu. The Socorro station acted as a control area because it was located out of the fallout zone. The ^{238}Pu results from both locations were below the detection level

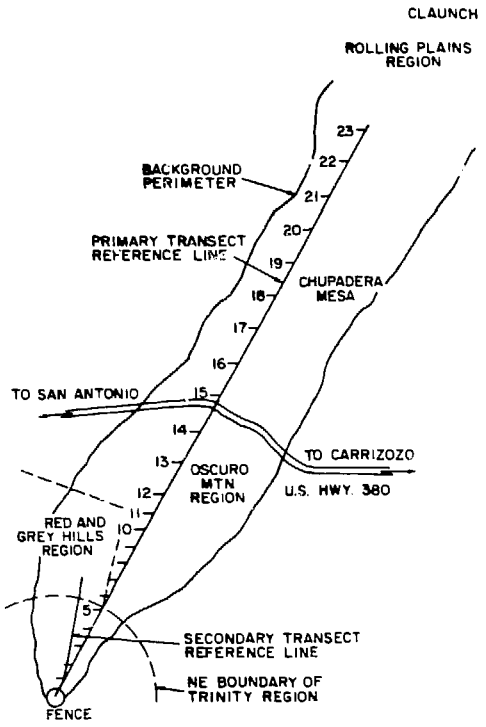

Fig. 6. Outline map of the contaminated area as determined by 1947 and 1948 survey. A transect was established with numbered laterals.

on many of the samples. Often, the results for $^{239,240}Pu$ also were below detection limits, and only the data pertaining to the detected plutonium were reported. The primary results of the air sampling indicated that the air concentrations were well below the proposed EPA limit for transuranics deposited on soils. The conclusion of the study indicated that, while higher plutonium levels could be found at very localized individual sites, the sampling density used in the study on Chupadera Mesa makes it unlikely that grossly higher levels are present in the area exceeding the EPA proposed guidance.

Because the EPA study limited itself to plutonium, it was decided that the 1977 resurvey of the fallout zone would include fission product and activation product measurements in addition to confirmatory plutonium measurements. Data for the resurvey concentrated in areas in the far fallout zone (the area north of White Sands Missile Range, and in particular, Chupadera Mesa) because, at the time, it was felt this was the most important area.

IV. THE RESURVEY OBJECTIVES

As previously mentioned, a number of studies have taken special views of either the early distribution of fission products, or later, the distribution of plutonium. The special Los Alamos ecology studies concentrated on intensive studies of four relatively small areas, 1 hectare in size. The EPA study concentrated on the characterization of plutonium mainly in the Chupadera Mesa area. These data are included in the data base of this study (Appendix A). The objective of this study, however, was twofold. The first objective, that of the resurvey program, was to design a sampling program that would allow the estimation of radiological dose to people living in the area for current land uses. These land uses are for grazing cattle and small home gardens. It is anticipated that GZ and the White Sands Missile Range will remain in control of the U.S. Army. Second, because a data base existed for a number of years and it is known from the earlier studies that wind and water played a major role in redistribution of the fallout material, it was decided that the study would also make special measurements to investigate redistribution of the materials from the actions of wind and rain. Because high-resolution germanium lithium-drifted [Ge(Li)] gamma detectors now exist, and are usable under field situations, it was decided to use the Lawrence Livermore Laboratory mobile radiation detection system. Use of the germanium detector with a pulse height analyzer in a mobile unit enabled the measurement of the distribution of fission products in soil in a rapid manner.

Redistribution of the surface-deposited fission products and plutonium was an important consideration of the studies carried out during the UCLA series in 1947 to 1951. A strong redistribution of surface soil by both wind and rain was observed. Flash floods do occur in the area and tend to move soils and sediments in runoff channels in large quantities. Points of deposition for these sediments that are moved by heavy water events are usually low points that are often dug out to collect the water for livestock watering. Therefore, the study included a number of measurements where the ^{137}Cs content was measured both upslope and at the final deposition point for redistribution of the fission products and probably of plutonium also.

To evaluate the significance of the residual contamination at the GZ location, a series of core samples was taken in 1983.

3. METHODS AND APPROACH

This study was designed to supplement existing data on the distribution of fallout from the Trinity Test to allow estimation of potential radiation doses based on land use. The sampling program took advantage of previous studies of the fallout area, as well as special studies of small areas of the fallout zone.

I. APPROACH

Previous surveys had determined the extent of the fallout area and general concentrations of surface deposition of fallout. Later studies by Los Alamos National Laboratory concentrated on the mechanisms for redistribution of the fallout in several intensive study areas.[14] In the case of the U.S. Environmental Protection Agency studies, the principal investigator provided field notes so sample locations could be relocated for further sampling.

The sampling programs were carried out during two time periods. In 1977 the far fallout zone, Chupadera Mesa, and areas around GZ on White Sands Missile Range were sampled. Because time and resources were limited, maximum use of previous survey results guided the plan for characterization of the residual fallout radionuclides. Also, the loan of a van with instrumentation and personnel from Lawrence Livermore National Laboratory allowed use of real-time data for decisions about measurement locations in the field. In 1983 a set of measurements and samples was taken at GZ. Analysis of the 1977 survey data had indicated more detailed information on the depth distribution of radionuclides at GZ would be necessary for engineering studies of the area. In both surveys, *in situ* measurements with a germanium lithium-activated [Ge(Li)] high-resolution gamma-ray spectrometer and special sampling methods were used to obtain information on the concentrations and location of radionuclides.

II. METHODS

A. *In Situ* Measurement

In planning the Trinity survey effort, it was determined that the utilization of *in situ* Ge(Li) spectrometry would provide a number of advantages over sole reliance on traditional soil-sampling techniques for obtaining an inventory of radionuclides in the soils of a very large Trinity fallout field. The following considerations were taken into account.

(a) The relatively short counting time required to obtain a satisfactory gamma spectrum for a sample (30 min compared with 1000-2000 min in the laboratory for a 100-g soil sample) allows a potentially larger number of sample locations to be examined. Alternatively, it allows the reallocation of laboratory Ge(Li) analysis time to the necessary soil profile concentration determinations in support of the *in situ* measurements.

(b) Local inhomogeneities in soil radionuclide concentration (both in depth and in small regions) are automatically averaged because the detector is responding to photons from a very large quantity of soil (several metric tons compared with a few hundred grams in a laboratory system).

(c) Combining the inherently high resolution of a Ge(Li) spectrometer system with a mobile detector and support system permits immediate feedback in the field of both radioisotope identity and relative activity (cpm), which allows on-site decisions to be made concerning what additional or different measurements might be needed and where.

The methodology and instrumentation for and feasibility of utilizing *in situ* Ge(Li) spectroscopy for identifying and quantifying radionuclides distributed in soil have been investigated and successfully demonstrated at several laboratories over the past several years.[15-19] For the Trinity resurvey, equipment and techniques developed by the Lawrence Livermore National Laboratory (LLNL) were utilized through a cooperative arrangement. An overview of the system and its calibration are found in published reports.[17]

The response of a closed-end, cylindrical Ge(Li) detector, placed at a fixed height (1 meter) above the soil, is an energy-dependent function of the angular response of the detector and the flux of unscattered photons incident on the detector per unit of soil radioactivity. Normally, calibration of this response involves laboratory measurements and calculational procedures independent of the geometries of the distributed sources to be evaluated. Radionuclides that have been redistributed through the vertical soil profile from an initial surface deposition (for example, fallout) are usually assumed to be exponentially distributed in this calibration calculation. As a crosscheck of the laboratory calibration and the suitability of the exponential distribution assumption, an empirical calibration factor for ^{137}Cs was derived as well.

Although detector response to a source does depend on such variables as the mass attenuation coefficients and densities of soil and air under field conditions, the crucial variable is the specification of the relaxation depth of the activity being measured (that is, the inverse of the power of the exponential distribution function). Under certain circumstances this parameter can be readily and reliably estimated, as in the case of fresh fallout of short-lived radionuclides (^{7}Be, for instance) or the case of naturally occurring radionuclides such as uranium, which tend to be uniformly distributed in soil. But the case of aged, long-lived fallout radionuclides deposited over as large and varied terrain as is found in the Trinity fallout field presents a more difficult condition to interpret. Concentration profiles for ^{137}Cs were determined at reasonably representative locations throughout the field by the technique of soil sampling and laboratory Ge(Li) analysis. As might be expected, these distributions reflect in a complex way the effects of the wide differences in rainfall input, soil properties and depth, and vegetation type and density, which occur over the range of low-elevation, dry desert terrain, through the grass and piñon-juniper habitat of the mesas, to the conifer forests of the mountain slopes. Representative values were selected and assigned by judgment to each sample location. An effort to develop a linear box model of redistribution of ^{137}Cs following deposition was made, but the many uncertainties in estimating the relevant parameters in the model led to results judged to be of no more value than making assignments on the basis of proximity to measured profiles, similarity of soil type, vegetation, elevation, and so forth.

B. Sampling and Analysis

Sampling of soils, sediments, and vegetation accompanied most *in situ* measurements throughout the survey area. Of particular importance were soil profile samples taken at the location of the *in situ* measurement. These soil profile samples were used to develop a correction factor for calibration of the Ge(Li) detector system to account for the depth distribution of gamma-ray emitting radionuclides.

The methods used for obtaining samples and subsequent analysis considered the sensitivity of the systems used and the survey design. At locations with changing topographical features, additional soil samples were taken to study plutonium and strontium distribution. These isotopes are not present in sufficient quantity for detection by the *in situ* measurement system used.

Soil samples were obtained using a 12.8-cm- (5-in.-) diameter ring that was pushed or pounded 5 cm (2 in.) into the soil. Soil was removed from around the ring by use of a shovel and hand trowel. An aluminum sheet was pushed under the ring and both soil and ring were lifted out. The soil was collected in plastic bags labeled with the location identification and an indication of the depth and soil horizon sampled. The procedure was repeated for each soil profile sample, taking care to avoid cross contamination. At each *in situ* measurement location, three 5-cm-deep soil profiles or a total of 15-cm- (6-in.-) deep samples were obtained. At selected locations, profile depths to 40 cm (16 in.) were sampled.

Vegetation samples were collected using grass shears to cut the grass or weeds within 1 to 5 cm of the soil surface. For trees, new growth and the last year's growth were collected. Samples were placed in plastic bags with notation of the plant species and the identification number for that location. Notes were made on the vegetative cover, measured slope, and soil characteristics. Topographic features of the surrounding area also were noted. Additional vegetation samples were collected for later verification of species types.

Soil and vegetation samples were transported daily to laboratories at New Mexico Institute of Mining and Technology in Socorro, New Mexico. Samples were placed in drying racks of window screen on wood frames in an unused greenhouse. After initial air drying, heat lamps were used to dry the samples to constant weight. Constant weight was attained in 1 hour under the heat

lamps. A drying time of 2 hours for both soils and plants was used as routine practice. After they were dried, soil and plant samples were pulverized using Waring Blendors. Vegetation samples were packed into cans by overfilling above the top of the container. A manual can sealer compressed the sample while the lid was fastened to the can. About 80 g of dried vegetation was sealed in the can for later counting on a laboratory Ge(Li) detector system. At the same time, 10.05 g of sample was weighed into a plastic sample bottle and labeled for transport to Los Alamos National Laboratory, where radiochemical analyses were conducted. Soil samples were homogenized and about 360 g filled the cans. Samples of 10.05 g of each soil or sediment sample were placed in small plastic bottles and labeled for transport to Los Alamos National Laboratory radiochemical laboratories.

Because the soils were anticipated to contain greater quantities of radionuclides than vegetation, a separate laboratory was used for soil handling. Samples from the GZ area were handled with special precautions because of higher radionuclide contents. Special laboratory cleaning before and after handling these segregated samples minimized cross-contamination potential.

Vegetation and soil samples were counted on a Ge(Li) system at New Mexico Institute of Mining and Technology as an initial screening method for radionuclide identification. Final analysis of the samples for gamma-emitting radionuclides was conducted by LLNL with calibrated laboratory Ge(Li) systems and data reduction accomplished using computer codes.[20]

Vegetation and soil samples sent to the Los Alamos environmental surveillance radiochemistry laboratories were analyzed for ^{238}Pu, $^{239,240}Pu$, and ^{90}Sr.[21] Plutonium analyses used standard digestion, anion exchange, plating, and alpha spectroscopy methods. Strontium-90 analyses utilized standard ^{90}Y ingrowth methods.

4. RESULTS

I. TOTAL AREA

For an overview of the amount of radioactive fallout from the Trinity Test, the data have been reviewed for overall measurement of ^{137}Cs, $^{239,240}Pu$, and other radionuclides. Figure 7 is a general map of the Trinity fallout area. Data points are designated as small squares. The solid lines divide the data base into areas of general interest for assessment of the radionuclides on more area-specific bases. The data base was divided into areas designated: Trinity GZ, San Antonio, White Sands Missile Range, Bingham, Chupadera Mesa, and Far Fallout Zone. Section II of the Results presents the mean data by area. Appendix A lists the data from all data bases summarized in the Results section of this report.

A. Trinity Data Analysis: ^{137}Cs in Soil

There are three independent modes of measurement of radionuclide content in Trinity soils used: (1) direct, *in situ* gamma spectroscopy, (2) laboratory gamma spectroscopy of canned soil samples, and (3) laboratory radiochemical analysis of soil samples. (See Chapter 2 of this report for details.) There is only limited overlap of determination of specific radionuclides by these approaches. In the case of ^{137}Cs, only *in situ* spectroscopy and laboratory spectroscopy of canned samples were applied: one providing inventory estimates and the other soil concentration data. In application, these two sources of information on ^{137}Cs inventory are not totally independent. The *in situ* measurement requires knowledge of

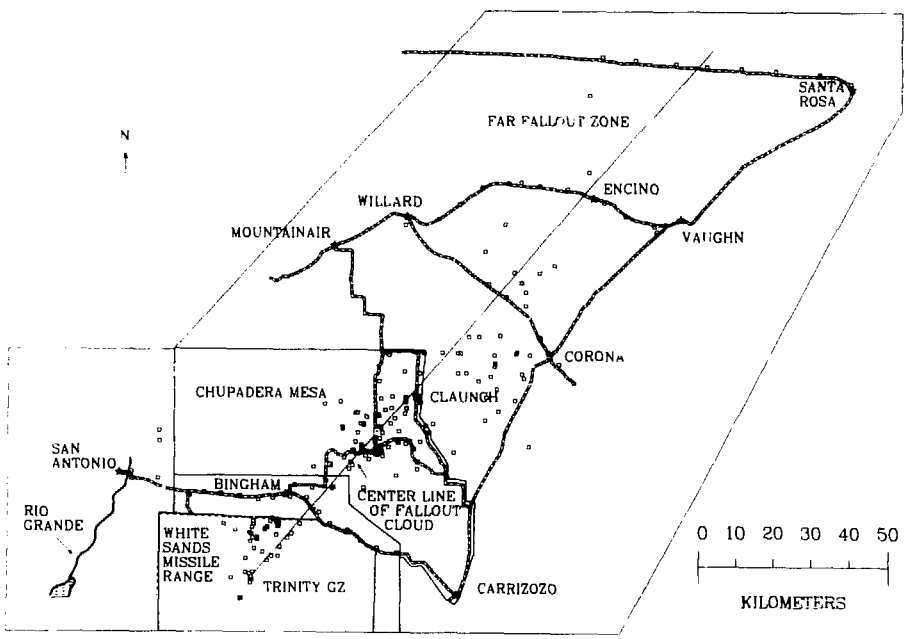

Fig. 7. General map of the Trinity fallout area and the measurement locations.

the vertical distribution pattern in the soils in the vicinity of the detector in order to be translated into an inventory estimate. The soil sampling results can be used to provide this needed distribution estimate. A discussion of the reduction of these data to provide ^{137}Cs inventory estimates follows.

Soil samples were collected at a large number of locations throughout the survey area at locations where *in situ* spectroscopy measurements were made (but not at every such location). Usually samples were collected at three consecutive 5-cm depth intervals. However, when these samples were processed, not all samples were prepared and counted. Profiles for which complete or nearly complete ^{137}Cs concentration data exist are shown in Table III.

An estimate can be made of the ^{137}Cs concentration in those samples that were counted, but for which no cesium data were reported based on the minimum detectable activity (MDA). Using the MDA estimate in those instances where a sample was counted but no ^{137}Cs data were reported provides an upper-bound estimate of inventory. One approach to estimating the MDA for ^{137}Cs is to examine the trend in uncertainty in the reported data. The MDA can be taken to be the smallest amount of activity that would likely be reported with an error not greater than some acceptable limit, say 33%. At an uncertainty of 33%, the corresponding concentration is approximately 0.1 pCi/g. Another approach based on statistical considerations, described in Appendix E, yields similar estimates.

Replacing MDA everywhere by the estimate of 0.1 pCi/g substantially increases the number of profile estimates. The profile characterization is by means of an exponential fitting function:

$$C = C_o \exp(-\alpha x) \qquad (1)$$

where C is the concentration at depth x, C_o is the surface concentration, and α is the inverse relaxation depth of the distribution. This relation can be justified theoretically on the basis of a simple box model in which the soil profile is characterized by a sequence of boxes that exchange contaminants over a period of time at a certain flow rate (A. T. Jakubide, *Migration of Plutonium in Natural Soil*, 1977). To incorporate the uncertainties in the concentration determinations into the profile characterization (that is, into the determination of the inverse relaxation depth estimate), a logarithmic transformation of Eq. (1) is made and the method of linear least squares applied with some modification to compensate for the fact that, unadjusted, the least-squares estimate underemphasizes the uncertainties for small values of C. (See Appendix C, least-squares fitting of an exponential function.)

The resulting alpha estimates for the Chupadera Mesa are shown in Table IV and GZ samples in Table V. Evidently, the mesa samples are characterized by a shallower profile (large alpha), and show less variability than the GZ samples do. This reflects, perhaps, the mechanical disturbance of GZ soils but also differences in the original deposition processes over these two areas, the geochemistry of the respective soils, and other environmental factors such as precipitation frequency, intensity, and so forth.

An estimate of the inventory of ^{137}Cs (nCi/m^2) in these soils can be made utilizing the concentration and profile data. Since there can be expected considerable mixing in the topmost layer of soil, the average concentration at the midpoint in the 0- to 5-cm interval will be taken to be representative of the 0- to 2.5-cm interval as well. (This estimation should tend to overestimate the actual inventory because there is most likely a parabolic distribution shape in the near surface layers caused from depletion processes at the surface.) Then the estimate of the inventory in the 0- to 2.5-cm interval is given, for a density of 1.5 g/cm^3, by

$$I_{2.5} = C_{2.5}\,(pCi/g) \times 2.5\ cm \times 1.5\ (g/cm^3) \times 10^4\ (cm^2/m^2) \times 10^3\ (nCi/pCi) = 37.5\ C_{2.5}\ . \qquad (2)$$

Then the total inventory can be estimated over the rest of the profile assuming the fitted exponential distribution:

$$I_{2.5-\infty} = 37.5C_{2.5} + \left(\int_{2.5}^{\infty} e^{-x}\ dx\right)(1.5)(1.0)(C_{2.5}) \cong \left(37.5 + \frac{15}{\alpha}\right) C_{2.5} \pm \sqrt{\frac{\sigma_c^2}{C^2} + \frac{\sigma\alpha^2}{\alpha^2}}\ , \qquad (3)$$

where the integral is approximated by one-half.

A comparison of the *in situ* inventory estimates with many of the soil sample estimates is possible and provides some measure of the compatibility of these two approaches to inventory estimation (Table VI). Because of delays in processing of canned soil samples, assignment of the α profile parameter for each sample location had to

TABLE III

^{137}Cs SOIL CONCENTRATION DATA

Location		Concentration (pCi/g)					
GZ or Mesa	LADB[a] No.	0-5 cm	FSD[b]	5-10 cm	FSD	10-15 cm	FSD
G	1990	13.6	0.011	21.7	0.013	6.98	0.036
G	1991	6.04	0.036	9.26	0.014	---[c]	---
G	1988	0.61	0.486	24.95	0.024	---	---
G	1989	1.75	0.122	0.17	0.179	MDA[d]	---
G	2006	0.35	0.188	0.28	0.185	---	---
G	2005	0.77	0.031	0.52	0.032	---	---
G	2012	0.38	0.227	0.41	0.127	MDA	MDA
G	2016	0.82	0.032	0.26	0.24	0.11	0.164
G	2018	0.26	0.173	0.26	0.058	0.15	0.355
G	2014	0.99	0.033	---	---	0.97	0.059
G	2019	0.54	0.057	0.38	0.108	0.14	0.299
M	2027	3.19	0.017	0.12	0.135	0.21	0.155
M	2026	5.42	0.063	0.48	0.097	MDA	MDA
M	2045	1.18	0.034	0.22	0.085	0.08	0.224
M	2048	1.08	0.047	0.13	0.274	0.19	0.296
G	1987	1.87	0.11	0.16	0.291	MDA	MDA
M	2053	0.71	0.056	---	---	0.06	0.204
M	2050	0.79	0.025	---	---	0.28	0.221
M	2057	2.56	0.017	---	---	MDA	MDA
M	2049	0.83	0.052	---	---	MDA	MDA
M	2115	2.95	0.027	0.09	0.192	MDA	MDA
M	2116	5.42	0.013	0.48	0.097	MDA	MDA
M	2118	2.06	0.03	0.10	0.162	MDA	MDA
M	2081	1.29	0.032	---	---	MDA	MDA
M	2080	0.32	0.081	---	---	0.11	0.163
G	1992	0.10	0.344	0.18	0.282	---	---
M	2120	1.75	0.030	1.0	0.040	MDA	MDA
M	2071	3.12	0.02	---	---	0.14	0.35
M	2058	5.14	0.01	---	---	0.08	0.34
M	2028	5.87	0.01	0.18	0.29	MDA	MDA
M	2059	1.04	0.04	---	---	MDA	MDA

[a]LADB - Los Alamos Data Base.
[b]FSD - Fractional Standard Deviation.
[c]--- means no data taken.
[d]MDA - Minimum Detectable Activity.

TABLE IV

CHUPADERA MESA ^{137}Cs PROFILE DATA

LADB[a] No.	C Conc at 2.5 cm (pCi/g)	FSD (B)[b]	$\alpha(cm^{-1})$	FSD (α)	Sequence
2026	5.42	0.013	0.33	0.64	0.4
2027	3.19	0.017	0.33	0.09	0.2
2028	5.87	0.010	0.53	0.16	0.4
2045	1.18	0.034	0.32	0.10	0.2
2048	1.08	0.047	0.22	0.29	0.4
2049	0.83	0.052	0.22	0.50	0.2
2050	0.79	0.025	0.10	0.40	0.2
2053	0.71	0.056	0.25	0.32	0.2
2057	2.56	0.017	0.33	0.33	0.4
2058	5.14	0.010	0.42	0.29	0.4
2059	1.04	0.040	0.24	0.45	0.4
2071	6.87	0.020	0.39	0.23	0.4
2080	0.32	0.081	0.11	0.48	0.2
2081	0.29	0.032	0.27	0.41	0.4
2115	2.95	0.027	0.49	0.17	0.7
2116	5.42	0.013	0.48	0.06	0.7
2118	2.06	0.030	0.47	0.16	0.7

Note: Mean $\alpha = 0.3235$ and $\sigma = 0.1281$.

[a]LADB - Los Alamos Data Base.
[b]FSD - Fractional Standard Deviation.

be made on the basis of limited information. Thus, there are a number of significant differences between the assumed α for *in situ* estimation and the fitted α for soil sample estimation (Table VII). However, corrected *in situ* estimates of inventory based on detector efficiencies as a function of α (Chapter II) were made corresponding to fitted α's and are shown in column 5 of Table VII.

Figure 8, a plot of soil-sample gamma *in situ* inventory estimates, suggests that the two estimation procedures yield similar results. A paired t-test was calculated for both corrected and uncorrected data (excluding sample 2014, which is a GZ sample), with the result that the two sample means are not significantly different at the 90% confidence limit in either the corrected or uncorrected cases. The α parameter correction appears to make only a small difference in comparability. Possibly the fact that the *in situ* technique is averaging over a considerably larger volume of soil at each sampling location than the corresponding soil samples is a compensating effect to the uncertainties in estimating α.

Thus, it would appear that the *in situ* ^{137}Cs total inventory estimates are comparable with soil sampling estimates with an uncertainty on the order of 50%.

TABLE V

GROUND ZERO TO CHUPADERA MESA
^{137}Cs PROFILE DATA

LADB[a] No.	Conc at 2.5 cm (pCi/g)	FSD (C)[b]	α (cm^{-1})	FSD (α)
1987	1.87	0.11	0.37	0.24
1988	0.61	0.486	0.12	0.17
1989	1.75	0.122	0.40	0.07
1990	13.60	0.011	0.06	0.01
1991	6.04	0.036	0.08	0.04
1992	0.10	0.344	0.12	2.17
2005	0.77	0.031	0.08	0.14
2006	0.35	0.188	0.04	2.12
2012	0.38	0.227	0.03	2.51
2014	0.99	0.033	0.002	0.006
2016	0.82	0.032	0.21	0.21
2018	0.26	0.173	0.02	4.27
2019	0.54	0.057	0.08	0.43

[a]LADB - Los Alamos Data Base.
[b]FSD - Fractional Standard Deviation.

B. Trinity Data Analysis: ^{239,240}Pu in Soil

Direct determination of the concentration and inventory of plutonium in Trinity soils was carried out by soil sampling and radiochemical analyses. Preliminary investigation of the possibility of utilizing the determination of ^{241}Am inventory as an indirect means of determining ^{239,240}Pu inventory proved unsuccessful because of an observed very low concentration of ^{241}Am in the Trinity soils, even in the vicinity of GZ.

The soil radiochemical results are tabulated in Table VIII. These data indicate a fairly rapid decrease in plutonium concentration with depth in most cases. But there are some significant exceptions such as at sample location 2072, which is a flat, grassy sediment trap on Chupadera Mesa. Here, relatively high concentrations (>1 pCi/g) persist to a depth of 10 to 15 cm. Deep distribution of plutonium might be expected to occur in such sediment traps; however, no systematic attempt was

TABLE VI

^{137}Cs INVENTORY ESTIMATES

A. Chupadera Mesa

LADB[a] No.	1-cm Inventory (nCi/m^2)	FSD	Total Inventory (nCi/m^2)	FSD[b]
2026	81.3	0.013	449.6	0.64
2027	47.85	0.017	264.6	0.09
2028	88.05	0.010	386.3	0.18
2045	17.70	0.034	99.56	0.11
2048	16.20	0.047	114.1	0.29
2049	12.45	0.052	87.7	0.50
2050	11.85	0.025	148.1	0.40
2053	10.65	0.056	69.2	0.32
2057	38.4	0.017	212.4	0.33
2058	177.1	0.01	376.3	0.39
2059	15.6	0.04	104.0	0.45
2071	103.05	0.02	521.9	0.23
2080	4.89	0.081	55.6	0.48
2081	19.35	0.032	120.0	0.41
2115	44.25	0.027	200.9	0.17
2116	81.30	0.013	372.6	0.06
2118	30.90	0.030	142.9	0.16

B. GZ to Chupadera Mesa

1987	28.05	0.11	145.9	0.26
1988	9.15	0.49	99.1	0.51
1989	26.25	0.12	131.25	0.20
1990	204.0	0.01	3710.0	0.01
1991	90.6	0.036	1359.0	0.05
1992	1.5	0.344	16.25	2.17
2005	11.55	0.031	173.25	0.14
2006	5.25	0.188	144.4	3.1
2012	5.70	0.227	204.3	0.23
2014	14.85	0.033	7462.1	0.03
2016	12.30	0.032	89.32	0.21
2018	3.90	0.173	204.75	4.2
2019	8.10	0.057	121.5	0.43

[a]LADB - Los Alamos Data Base.
[b]FSD - Fractional Standard Deviation.

TABLE VII

COMPARISON OF IN SITU AND SOIL SAMPLE ESTIMATES OF ^{137}Cs TOTAL INVENTORY (nCi/m^2)

LADB[a] No.	Assumed α	Inventory *In Situ* Reported	σ	Inventory Corrected[b] for α	Inventory Soil Sample Estimate	FSD[c]	Measured α
2012	0.2	236.6	5.73	701.3	204.3	0.23	0.03
2014	0.03	858.2	25.29	1501.9	7462.1	0.03	0.002
2016	0.20	84.58	4.46	84.6	89.3	0.21	0.21
2018	0.20	90.92	2.96	269.5	204.8	0.17	0.02
2019	0.20	26.43	1.19	99.7	121.5	0.10	0.08
2026	0.40	540.0	49.28	597.9	449.6	0.64	0.33
2027	0.20	314.0	4.74	232.7	264.6	0.09	0.33
2049	0.20	139.6	3.53	139.6	87.7	0.50	0.22
2050	0.20	125.2	3.43	185.6	148.1	0.40	0.10
2053	0.20	189.0	4.01	189.0	69.2	0.32	0.25
2057	0.40	158.7	3.04	175.7	212.4	0.33	0.33
2058	0.40	323.4	4.22	323.4	376.3	0.29	0.42
2059	0.40	211.3	3.40	284.8	104.0	0.45	0.24
2071	0.40	388.7	5.35	388.7	521.9	0.23	0.39
2080	0.20	81.5	2.91	120.8	55.6	0.48	0.11
2081	0.40	135.5	2.74	168.0	120.0	0.41	0.27
2115	0.70	83.7	2.12	98.3	200.9	0.17	0.49
2116	0.70	84.4	2.23	98.7	372.6	0.06	0.48
2118	0.70	100.0	2.23	120.9	142.9	0.16	0.47

[a]LADB - Los Alamos Data Base.

[b]The number of counts in the ^{137}Cs photopeak is converted to nCi/m^2 by a detector efficiency term N_f/s, which is a function of α. The ratio of the efficiency values for the assumed α and actual measured α from profile data was used to evaluate a corrected *in situ estimate.*

[c]FSD - Fractional Standard Deviation.

made to fully explore the extent of vertical redistribution of plutonium in soils.

As in the case of ^{137}Cs soil concentrations profile data, these plutonium data can be fitted by an exponential distribution model in most cases to provide an estimate of distribution with depth, and thereby, inventory. Least-squares fitting of these data (where possible) with an exponential fitting function yield the results tabulated in Table IX.

These profile characterizations clearly point to the highly variable or indeterminate distribution conditions of the GZ area due possibly to mechanical disturbance in the characteristics of the fallout materials, and so forth. The fit of the shapes of the concentration depth profiles to an exponential function is reasonably good on Chupadera Mesa; but there are some notable exceptions. Some of the cases where there is considerable uncertainty in the profile parameter α are probably attributable to very low concentrations, especially at greatest depth, with consequent poor recovery and counting statistics. Others (sample 2080, for example) may reflect other processes at

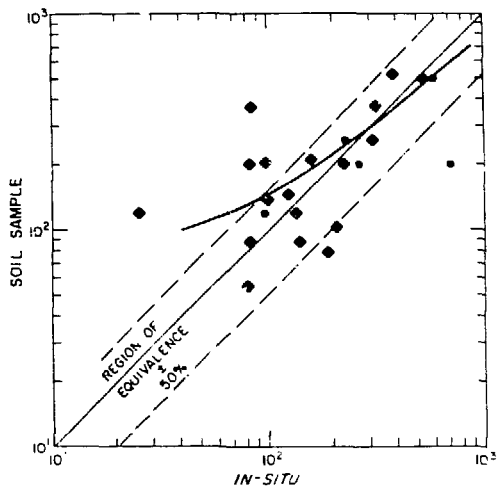

Fig. 8. Comparison of in situ and soil sample estimates of total ^{137}Cs inventory.

work affecting vertical redistribution rather than infiltration, such as disturbances by burrowing rodents, cattle, or big game animals.

Concentrations of ^{238}Pu in these soils are so low as to make reliable estimates of profile distributions, and consequently total inventory, impossible. Table X illustrates the order of magnitude of some surface (0- to 5-cm) concentrations and corresponding $^{238}Pu/^{239}Pu$ ratios. There is apparently about 20 times more ^{239}Pu than ^{238}Pu in the surface soils, independent of location.

The $^{239,240}Pu$ inventory estimate was made utilizing the same strategy as was used for ^{137}Cs inventory estimates, that is, by assuming an essentially uniform concentration in the 0- to 2.5-cm layer, and a decreasing exponential distribution over the remainder of the profile. On these assumptions, the 0- to 1-cm inventory I_1 (most readily available for resuspension) and the total inventory I_T estimates are given, assuming again a density of 1.5 g/cm^3,

$$I_1 \cong 15C_{2.5} \pm \sigma_c$$

and

$$I_T \cong \left(37.5 + \frac{15}{\alpha}\right) C_{2.5} \pm \sqrt{\frac{C^2}{\sigma c^2} + \frac{\alpha^2}{\sigma_\alpha{}^2}} \cdot \qquad (4)$$

These two inventories are tabulated in Table XI for those cases where adequate data exist. Samples for which either the profile estimate could not be made or for which the uncertainty in the surface concentration and/or profile α estimates were too great to provide useful total inventory estimates, still have a surface inventory estimate listed. Evidently in the case of GZ environs samples, only the near surface inventory estimate is usable.

C. Other Fission and Activation Products in Soils

In addition to cesium and plutonium, several fission products and activation products from the Trinity event and more recent Chinese nuclear tests were detected by the Ge(Li) systems used. The activation and fission products from the relatively recent fallout were detectable at most locations by observing the ^{95}Zr and ^{95}Nb gamma rays in the *in situ* spectra. The average ^{95}Zr (half-life, 64 d)[22] areal concentration for the approximately 2500 mi^2 surveyed was 2.4 ± 0.12 nCi/m^2 and the ^{95}Nb (half-life, 35.1 d)[22] average concentration was 3.8 ± 0.15 nCi/m^2. The range of concentrations was from undetectable to 6.6 nCi/m^2 for ^{95}Nb. Of the 116 measurement locations for ^{137}Cs, ^{95}Zr was detected at 88 locations and ^{95}Nb at 92 locations.

Other short-lived radionuclides detected by the *in situ* Ge(Li) system were ^{7}Be and ^{103}Ru. The relatively short half-lives of 53.4 d[22] for ^{7}Be and 39.3 d[22] for ^{103}Ru also identify these radionuclides as being part of fallout from the 4-megaton Chinese nuclear test on November 17, 1976.[7] The ^{7}Be concentration on an areal basis averaged 8.1 ± 0.7 nCi/m^2 with a range from undetected to 26 nCi/m^2. Of the 116 locations monitored for ^{137}Cs, 62 locations had detectable ^{7}Be. Only 22 out of the 116 locations contained detectable ^{103}Ru with concentrations for the area surveyed averaging 0.21 ± 0.04 nCi/m^2. The range was from undetectable quantities to 1.9 nCi/m^2.

The *in situ* gamma spectra and laboratory analyses of soil indicated the presence of the activation and fission products ^{60}Co, ^{152}Eu, and ^{155}Eu. Because of the longer half-lives associated with these radionuclides, the quantities present are considered to be from the Trinity test. The half-life of ^{60}Co is 5.27 yr; ^{152}Eu, 14 yr; and ^{155}Eu, 5 yr.[22] The areal concentration of these radionuclides at two GZ locations as measured by *in situ* methods indicated 5000 nCi/m^2 and 50 nCi/m^2 of ^{60}Co and 1.1 × 10^4 nCi/m^2 and 1.2 × 10^3 nCi/m^2 of ^{155}Eu. For areas

TABLE VIII

TRINITY SOIL CONCENTRATION OF $^{239,240}Pu$

Location		Activity (pCi/g)									
LADB[a] No.	GZ or Mesa (M)	0-5 cm	FSD[b]	5-10 cm	FSD	10-15 cm	FSD	15-20 cm	FSD	20-25 cm	FSD
1998	GZ	24.3	0.02	57.4	0.02	0.15	0.47	...[c]	---	---	-
2001	GZ	64.9	0.02	44.4	0.02	201	0.01	---	---	---	---
2003	GZ	3.8	0.05	0.05	0.80	-0.06	0.67	---	---	---	--
2009	GZ	0.48	0.04	0.45	0.04	0.47	0.04	---	---	--	--
2014	M	0.165	0.05	0.71	0.03	0.146	0.86	---	---	--	---
2016	GZ	0.122	0.08	---	---	-0.68	0.04	---	---	---	---
2018	GZ	0.67	0.04	-0.001[d]	2.0	---	---	---	---	---	---
2026	M	3.51	0.03	0.118	0.07	0.018	0.22	---	---	---	---
2027	M	1.71	0.03	0.204	0.05	0.074	0.08	---	---	---	---
2028	M	4.07	0.04	0.109	0.06	0.007	0.28	---	---	---	---
2037	M	1.83	0.02	0.082	0.06	---	---	---	---	---	---
2047	M	0.98	0.04	0.241	0.06	0.172	0.05	0.013	0.231	0.007	0.29
2052[e]	M	0.122	0.07	0.004	0.75	0.010	0.0001	0.0017	0.71	---	---
2048	M	0.398	0.058	0.019	0.168	0.0059	0.32	---	---	---	---
2049	M	0.246	0.04	---	---	0.001	1.55	---	---	0.002	1.50
2057	M	0.70	0.03	0.383	0.05	0.01	0.0001	---	---	---	---
2059	M	1.21	0.06	0.033	0.15	0.018	0.17	---	---	---	---
2060	M	1.06	0.04	0.302	0.04	0.157	0.08	0.088	0.10	0.053	0.01
2065	M	0.271	0.04	0.002	0.71	-0.001	1.29	---	---	---	---
2071	M	1.54	0.03	---	---	0.061	0.10	---	---	---	---
2072	M	4.58	0.03	3.88	0.03	1.15	0.03	---	---	---	---
2073	M	6.70	0.03	---	---	---	---	---	---	---	---
2076	M	0.435	0.03	0.018	0.17	0.016	0.09	---	---	--	---
2080	M	0.027	0.15	0.024	0.17	0.016	0.19	---	---	---	---
2082	M	0.95	0.04	0.010	0.20	-0.001	1.0	---	---	---	---
2084	M	1.23	0.04	0.056	0.11	0.009	0.44	---	---	---	---
2096	M	0.213	0.06	0.002	1.50	-0.003	1.0	---	---	---	-
2097	M	0.61	0.05	0.153	0.04	0.007	0.43	---	---	0.002	0.94
2115	M	0.25	0.16	0.021	0.19	0.0013	1.15	---	---	---	--
2118	M	0.18	0.07	0.013	0.23	0.001	4.0	---	---	---	---
2119	M	0.17	0.06	-0.01	2.0	0.005	1.0	---	---	---	---
2120	M	0.23	0.13	0.60	0.05	0.037	0.14	---	---	---	---
2121	M	0.69	0.04	0.51	0.04	---	---	---	---	---	---

[a]LADB - Los Alamos Data Base.
[b]FSD is the standard deviation of the measured value divided by the measured value.
[c]Blanks indicate that sample was not taken or not analyzed.
[d]Additional profiles: 25-30 cm, 0.007 (1.8) pCi/g; 30-35 cm, 0.0023 (0.61) pCi/g; 40-45 cm, 0.0075 (0.25) pCi/g.
[e]Negative values represent observations smaller than chemical blank values.

TABLE IX

GZ ENVIRONS AND CHUPADERA MESA ^{239,240}Pu SOIL CONCENTRATION PROFILE ESTIMATES

LADB[a] No.	Surface Soil Concentration: C = Conc at 2.5 cm (pCi/g)	FSD (C)[b]	Inverse Relaxation Depth of Profile: α (cm^{-1})	FSD (α)[b]
1995	(uniformly uncontaminated at background)			
1998	(α indeterminate—disturbed soil at GZ)			
2001	(α positive—disturbed soil GZ)			
2003	3.8	0.05	0.86	16.5
2009	0.48	0.04	0.001	12.9
2016	(α positive—disturbed soil)			
2018	(α indeterminate—surface deposit only)			
2026	3.51	0.03	0.67	0.06
2027	1.71	0.03	0.38	0.05
2028	4.07	0.04	0.72	0.05
2037	1.83	0.03	0.62	0.07
2047	0.98	0.04	0.19	0.06
2048	0.39	0.05	0.56	0.36
2049	0.25	0.04	0.28	5.74
2052	0.12	0.07	0.25	0.09
2057	0.70	0.03	0.34	0.03
2059	1.21	0.06	0.53	0.19
2060	1.06	0.04	0.19	0.05
2065	0.27	0.04	1.01	3.38
2071	1.54	0.03	0.32	0.12
2072	4.58	0.03	0.11	0.02
2073	(α indeterminate—only surface sample tested)			
2076	0.44	0.03	0.41	0.31
2080	0.03	0.15	0.05	3.53
2082	0.95	0.04	0.91	0.44
2084	1.23	0.04	0.61	0.15
2096	0.21	0.06	0.93	7.19
2097	0.61	0.05	0.28	0.09
2115	0.25	0.16	0.49	0.54
2118	0.18	0.07	0.52	0.78
2119	0.17	0.06	0.35	4.03
2120	(α positive—disturbed soils in stream channel)			
2121	0.69	0.04	0.06	0.24

[a]LADB - Los Alamos Data Base.

[b]FSD - Fractional Standard Deviation.

TABLE X

SURFACE SOIL CONCENTRATION OF ^{238}Pu AND ^{238,239}Pu RATIOS

Location	Surface Conc of ^{238}Pu (pCi/g)	FSD[a]	^{238,239}Pu
2009	0.023	0.17	0.05
2014	0.0059	0.32	0.04
2016	0.004	0.50	0.03
2018	0.204	0.01	0.05
2047	0.045	0.11	0.05
2060	0.048	0.11	0.05
2065	0.012	0.17	0.04
2072	0.224	0.004	0.05
2073	0.323	0.05	0.05
2076	0.016	0.13	0.04
2082	0.046	0.11	0.05
2119	0.008	0.33	0.05
2121	0.041	0.10	0.06

[a]FSD - Fractional Standard Deviation.

outside of GZ, ^{60}Co was detected at 21 locations, whereas ^{152}Eu and ^{155}Eu were detected at only four locations *in situ*. The average ^{60}Co areal concentration area from ground zero areas was 2.5 ± 1.5 nCi/m^2. The ^{60}Co distribution for the fallout area does not correlate with the ^{137}Cs area concentrations. Away from ground zero areas, the correlation coefficient for ^{60}Co and ^{137}Cs is 0.05. There was no correlation between ^{60}Co and ^{90}Sr in soils.

Laboratory counting of the soil samples in tuna cans provided additional information about the fission products from the Trinity fallout at GZ. The following radionuclides: ^{60}Co, ^{137}Cs, ^{133}Ba, ^{152}Eu, ^{154}Eu, and ^{155}Eu were detected in most soil samples. Table XII indicates the range of soil concentrations of the radionuclides detected. The range is wide but not unusual in view of the disturbances of the Trinity GZ area. The area was plowed and bladed in 1945 to remove materials from the surface. In particular, the fused sand and soil called Trinitite was being picked up by visitors as a memento of the event. The surface was bladed and the Trinitite was buried in trenches in the GZ area in 1952. Other

TABLE XI

1977 ESTIMATES OF 1-cm AND TOTAL PLUTONIUM INVENTORY (nCi/m²)

LADB[a] No.	1-cm ^{239}Pu Inventory (I_1)	FSD[b] (I_T)	Total ^{239}Pu Inventory (I_1)	FSD[b] (I_T)
1995	Bkg (<0.01)	---	---	---
1998	364.5	0.02	[c]	---
2001	973.5	0.02	[c]	---
2003	57.0	0.05	[c]	---
2009	7.2	0.04	[c]	---
2014	2.5	0.05	[c]	---
2016	1.8	0.08	[c]	---
2018	10.1	0.04	[c]	---
2026	52.7	0.03	210.2	0.08
2027	25.7	0.03	131.6	0.13
2028	61.1	0.04	237.4	0.07
2037	27.5	0.03	112.9	0.11
2047	14.7	0.04	114.1	0.32
2048	5.9	0.05	25.1	0.66
2049	3.7	0.04	[c]	---
2052	1.8	0.07	11.7	0.69
2057	10.5	0.03	57.1	0.09
2059	18.2	0.06	79.6	0.36
2060	15.9	0.04	123.4	0.27
2065	4.1	0.04	[c]	---
2071	23.1	0.03	129.9	0.37
2072	68.7	0.03	796.3	0.18
2073	100.5	0.03	[c]	---
2076	6.6	0.03	32.6	0.76
2082	14.3	0.04	51.3	0.49
2084	18.5	0.04	76.4	0.25
2097	9.2	0.05	[c]	---
2115	3.8	0.16	17.0	1.27
2118	2.7	0.07	11.9	1.55
2119	2.6	0.06	[c]	---
2120	3.5	0.13	[c]	---
2121	10.4	0.04	[c]	---

[a]LADB - Los Alamos Data Base.
[b]FSD - Fractional Standard Deviation.
[c]Total inventory not calculated because of inadequate data (FSD > 3).

radionuclides identified with low confidence and expected in fallout gamma-ray spectra were ^{144}Ce and ^{125}Sb. These latter radionuclides are likely from the Chinese nuclear tests.

In selected soil samples from areas off the White Sands Missile Range, the predominant fission products detected were ^{137}Cs and ^{155}Eu. These samples are from a large area including Chupadera Mesa, Gallinas Peak, and the far fallout areas northeast of New Mexico State Highway 14. For laboratory counting, the 0- to 5-cm and 10- to 15-cm samples were selected for counting for *in situ* detector calibration. Selected 5- to 10-cm samples were counted, but they were fewer in number.

TABLE XII

ACTIVATION AND FISSION PRODUCTS IN BULK SOIL SAMPLES AT TRINITY GZ AREA

Isotope	Soil Sample Interval (cm)	Range of Conc (pCi/g)
^{60}Co	0 - 5	12 - 60
	5 - 10	12
	10 - 15	0.12 - 18
^{137}Cs	0 - 5	4.2 - 21
	5 - 10	0.52 - 48
	10 - 15	0.79 - 16
^{133}Ba	0 - 5	1.6 - 3.8
	5 - 10	0.58 - 2.9
	10 - 15	N.D - 1.5[a]
^{152}Eu	0 - 5	12 - 1300
	5 - 10	240 - 270
	10 - 15	N.D - 340
	0 - 5	16 - 76
	5 - 10	10 - 15
	10 - 15	N.D - 17

[a]Not detected.

The mean values for the ^{155}Eu activity in soil were 0.17 ± 0.12 pCi/g for the 0- to 5-cm depth and 0.14 ± 0.07 pCi/g for the 10- to 15-cm depth. An analysis of variance indicates the means are equal at the 99% level of significance. The same samples have unequal means for ^{137}Cs concentration with the greatest amounts in the 0- to 5-cm samples. The equal concentrations of ^{155}Eu concentrations in the 0- to 5-cm and 10- to 15-cm soil depths indicate possible movement of Eu deeper into the soil with time. For a deeper soil sample of 20 to 25 cm in the same region but for only one location, the ^{155}Eu concentration was 0.23 pCi/g.

D. Natural Radioactivity in Soils

The *in situ* Ge(Li) detector system detects the gamma-emitting primordial radionuclides and these radiations can be used for calibration of the detector for energy. The quantities of ^{40}K are determined directly. The quantities

of ^{238}U and ^{232}Th are determined from the quantities of gamma-emitting daughter products. Use of the daughter products assumes radiological equilibrium between the parents and daughters with minimal or unimportant chemical redistribution in the soils.

The ^{40}K concentration, listed in Table XIII, averaged 17.7 ± 0.56 pCi/g for the region surveyed with a range of values from 3.4 to 42 pCi/g. The wide range of values is consistent with the variable geological features of the region surveyed. The NCRP report on natural background radiation in the U.S. summarizes the concentrations of major radionuclides in rock types and soil.[23] The expected range of values would be predicted to be between 2 pCi/g for carbonate rocks and 40 pCi/g for salic rocks. The geological formations of the region are composed of limestones and sandstones with a small area at the top of Gallinas Peak being intrusive rock identified as rhyolite. The highest value, 42 pCi/g, was from a region of volcanic rocks in a canyon area where ^{40}K content would be expected to exceed 30 pCi/g. Soils for the total U.S. averaged 12 pCi/g for *in situ* measurements taken by Lowder et al. in 1964 compared with the average of 18 pCi/g for this study.[24]

The concentrations of the natural radionuclides ^{232}Th and ^{238}U also varied within the study region. The ^{232}Th average concentration for all *in situ* locations was 0.94 ± 0.04 pCi/g with a range from 0.12 pCi/g to 2.8 pCi/g. The ^{238}U concentrations for *in situ* locations averaged 0.90 ± 0.03 pCi/g with a range from 0.32 pCi/g to 2.0 pCi/g. The highest values of ^{232}Th were detected at the top of Gallinas Peak where intrusive rocks occur. The highest uranium value was detected in an area that integrates water runoff in a basin area. Areas of exposed limestone where soils were relatively thin contained the lowest concentrations of ^{232}Th and ^{238}U, as expected from literature values.[23,24]

TABLE XIII

SOIL CONCENTRATIONS OF NATURALLY OCCURRING GAMMA-EMITTERS

Radionuclide	n	Mean Conc. (pCi/g) ± S.E.	Range (pCi/g)
^{40}K	101	17.7 ± 0.56	3.4 - 42
^{232}Th	101	0.94 ± 0.04	0.14 - 2.8
^{238}U	101	0.93 ± 0.03	0.32 - 2.0

II. DATA SUMMARY FOR SOILS

The separation of the overall data base into smaller locations of measurement of radionuclides generally followed topographic areas of the fallout area from the Trinity test. An artificiality of the boundary selection was the use of roads or a property boundary, which tends to result in a mixture of topographic features. However, directions and distances from GZ and land use all contributed to the choice of boundaries for separate data treatment.

The areas are bounded in Fig. 7 by solid lines. Trinity GZ is illustrated in Figs. 4 and 11. Located within a special fenced area on the White Sands Missile Range, Trinity GZ is the area of ground disturbance left from the initial test. Figure 9 indicates the sampling locations for the White Sands Missile Range, Bingham area, and Chupadera Mesa. Earlier surveys by Larson et al. and special studies by Hakonson et al. indicated localized areas of higher fallout on Chupadera Mesa.[6,9] Figure 7 includes the sample locations for the far fallout area. Figure 10 indicates the location of samples in the San Antonio area, which is west and out of the fallout path.

The soil data for each area are summarized in Tables XIV through XIX. The results listed in the tables are summaries of statistical treatment of the data by area to determine means and standard errors (standard deviation of the mean).[25] The dates associated with the $^{239,249}Pu$ determinations are the data from studies by Olafson and Larson in 1948 and 1950, Los Alamos in 1972, EPA in 1973 and 1974, and Los Alamos in 1977 and 1983. Also noted is the depth of soil samples taken because the sampling schemes used by different investigators varied.

A. Plutonium in Soils

From Appendix D, the level of $^{239-240}Pu$ in soils from worldwide fallout deposited in northern New Mexico is 0.008 ± 0.01 pCi/g. Of the areas listed in Tables XIV through XIX, only the San Antonio Area contains $^{239-240}Pu$ in soils at concentrations as low as Northern New Mexico fallout levels. The other areas of the fallout zone all contain $^{239-240}Pu$ above worldwide fallout levels.

The no action level proposed by the DOE Remedial Action Programs for $^{239,240}Pu$ is 100 pCi/g. The only

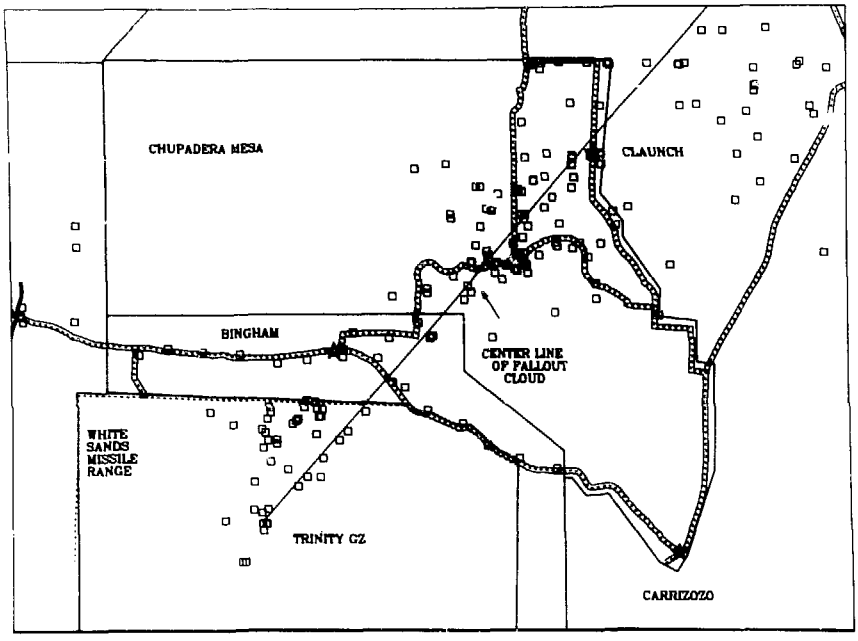

Fig. 9. White Sands Missile Range, Bingham, and Chupadera Mesa sample locations.

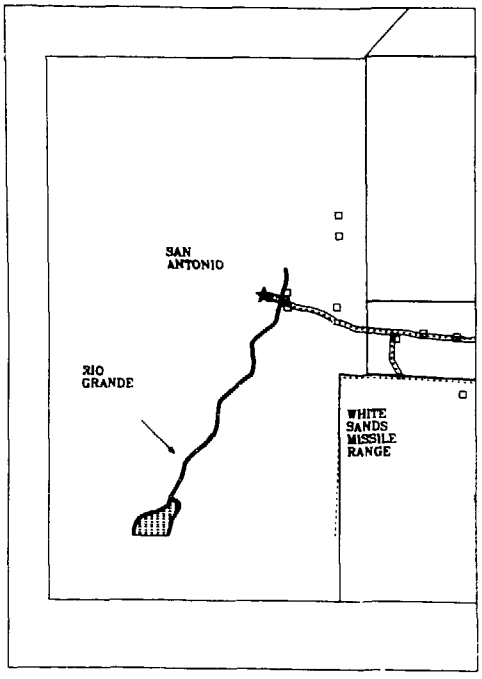

Fig. 10. Sample locations for the San Antonio area.

area exceeding this level of plutonium is the controlled inner fenced area of GZ. The EPA has proposed a screening level for no action of 200 nCi/m^2, which is equivalent to about 15 pCi/g in the top 1-cm layer of soil. Measurements of $^{239-240}$Pu in controlled areas of GZ exceed this proposed limit. Measurements made in 1972 within 1 km of GZ in the fallout path exceed this limit, but EPA measurements in 1973 and Los Alamos measurements in 1972 do not exceed the limits.

B. Cesium-137 in Soils

The amounts of ^{137}Cs in soils of the GZ area exceed the levels found in soils elsewhere in the U.S.[26,27] However, the amounts detected by *in situ* measurements on the White Sands Missile Range and other fallout areas are within the range of values reported for the areal distributions of worldwide fallout. Table XX lists a range of 19 to 305 nCi/m^2 from California to Connecticut. If the measurements at San Antonio are assumed to be levels representing worldwide fallout, the White Sands

TABLE XIV

GROUND ZERO SURFACE MEASUREMENTS

Radionuclide	N	Mean ± S.E.[a]	Min	Max
^{60}Co	6	5554 ± 3094 nCi/m^2	0	19 300
^{137}Cs	6	8104 ± 3772 nCi/m^2	488	23 000
^{152}Eu	6	107 200 ± 54 400 nCi/m^2	842	340 000
Natural gamma	6	7.9 ± 0.7 μR/h	5.5	10.0
Total gamma	6	131 ± 62 μR/h	9.8	397
^{40}K	6	24 ± 4.4 pCi/g	12	43
^{232}Th	6	0.86 ± 0.03 pCi/g	0.78	0.97
^{238}U	6	0.60 ± 0.13 pCi/g	0	0.88
$^{239,240}Pu$			[b]	
Inner fence, 0-1 cm	1	(1983) 22.8 ± 0.2 pCi/g	[b]	[b]
1-6 cm	1	(1983) 156 ± 15 pCi/g	[b]	[b]
0-15 cm	1	(1983) 23.7 ± 0.4pCi/g	[b]	[b]
15-30 cm	1	(1983) 256 ± 3 pCi/g	[b]	[b]
30-45 cm	1	(1983) 0.4 ± 0.02 pCi/g	[b]	[b]
Between fences, 0-1 cm	11	(1983) 5.8 ± 9.5 pCi/g	0.04	28
1-6 cm	9	(1983) 1.14 ± 2.9 pCi/g	0.02	8.8
15-30 cm	11	(1983) 0.0053 ± 0.003 pCi/g	0.002	0.01
Inner fence, 0-2.5 cm	2	(1972) 127 ± 180 pCi/g	0.04	255
Combined, 0-5 cm	3	(1977) 31 ± 31 pCi/g	3.8	64.8
5-10 cm	3	(1977) 34 ± 30 pCi/g	0.05	57
10-15 cm	3	(1977 67 ± 116 pCi/g	< MDA	201
^{137}Cs				
Inner fence, 0-1 cm	1	16.5 ± 3.3 pCi/g	[b]	[b]
1-6 cm	1	21.8 ± 4.4 pCi/g	[b]	[b]
0-15 cm	1	12.6 ± 2.5 pCi/g	[b]	[b]
15-30 cm	1	21.5 ± 4.3 pCi/g	[b]	[b]
30-45 cm	1	0.67 ± 0.19 pCi/g	[b]	[b]
Between fences, 0-1 cm	3	0.54 ± 0.37 pCi/g	0.17	0.92
1-6 cm	3	0.64 ± 0.48 pCi/g	0.29	1.19
4-10 cm	3	0.33 ± 0.12 pCi/g	0.22	0.32
10-15 cm	3	0.07 ± 0.41	-0.33	0.49

TABLE XIV (cont)

Radionuclide	N	Mean ± S.E.[a]	Min	Max
^{152}Eu				
Inner fence, 0-1 cm	1	284 ± 29 pCi/g	[b]	[b]
1-6 cm	1	245 ± 25 pCi/g	[b]	[b]
0-15 cm	2	382 ± 167 pCi/g	264	501
15-30 cm	2	1013 ± 79 pCi/g	957	1069
30-45 cm	2	225 ± 80 pCi/g	169	282
76-91 cm	2	12 ± 16 pCi/g	0.5	24
106-122 cm	2	2.2 ± 2.4 pCi/g	0.4	3.9
Between fences, 0-1 cm	8	20 ± 18 pCi/g	3.4	59
1-6 cm	8	18 ± 14 pCi/g	3.5	46

[a]S.E. - Standard Error.
[b]Single observation.

Missile Range, Chupadera Mesa, and Far Fallout Zone are 2.4, 4.2, and 2.2 times higher than levels expected in central New Mexico.

Cesium also can be used as an indicator of the slow changes in fallout distribution with time. Measurements by the *in situ* detector on Chupadera Mesa were made for different land forms at several locations. The Chupadera Mesa area has several closed drainage collection points where the water and associated sediments from rainfall runoff collect. Measurements were made on the slopes above a collection point and on the sediment bed in the dry collection areas. Table XXI summarizes the data taken for such drainage systems on Chupadera Mesa. The arithmetic mean values for ^{137}Cs on slopes above drainages and their associated collection points are not equal with a 99.5% confidence using Student's t-test for equal means. The data suggest that after 32 years the cesium bound to soils is slowly being transported into water and sediment collection points. However, the process appears to be slow and any increased areal concentration in the collection sediment points will be offset by radioactive decay with half of the activity disappearing every 30.2 years.

C. Strontium-90 in Soils

Measurements of ^{90}Sr in soils during the 1977 survey were restricted to relatively few samples because of analytical costs. From the limited data, comparisons of the ^{90}Sr in soils of Chupadera Mesa and the Far Fallout Zone with measurements of worldwide fallout in soils at various locations in the U.S. indicate a clear influence from the Trinity test. Table XXII summarizes data for locations in mountain states of the U.S.; ^{90}Sr levels in the fallout zone from the Trinity test range from 10 to 40 times those both north and south of central New Mexico.

III. AIRBORNE RADIOACTIVE MATERIALS

Airborne radioactive materials measurements at Trinity site and in the fallout zone are extremely limited. During the 1973 and 1974 survey by the EPA, a 10-month air sampling was conducted on Chupadera Mesa and at Socorro, New Mexico, a community out of the influence of the Trinity test.[13] Air concentrations of plutonium at both locations were equal, but isotopic ratios at Chupadera Mesa indicated the Trinity test plutonium contributed the major activity while worldwide fallout contributed the major activity at Socorro.[13]

Table XXIII includes plutonium concentrations in air samples taken at GZ and at a control site 5.2 km south of GZ in 1983. Also included are the air concentrations calculated for resuspended plutonium (see Appendix D for details).

Comparison of the calculated resuspended plutonium on Chupadera Mesa with the measured values indicates the calculations overestimate the actual amount by a

TABLE XV

WHITE SANDS MISSILE RANGE FALLOUT ZONE SOIL MEASUREMENTS

Radionuclide	N	Depth (cm)	Mean ± S.E.[a]	Min	Max
^{7}Be	22	---	5.7 ± 1.2 nCi/m^2	<MDA	19
^{60}Co	22	---	27 ± 23 nCi/m^2	<MDA	503
^{137}Cs	22	---	162 ± 42 nCi/m^2	2.1	858
^{152}Eu	22	---	77 ± 77 nCi/m	<MDA	1696
^{155}Eu	22	---	5.5 ± 4.0 nCi/m^2	<MDA	82
^{95}Nb	22	---	3.1 ± 0.26 nCi/m^2	<MDA	4.6
^{95}Zr	22	---	2.5 ± 0.27 nCi/m^2	<MDA	5
^{103}Ru	22	---	0.14 ± 0.08 nCi/m^2	<MDA	1.5
Natural gamma	23	---	7.8 ± 0.65 μR/h	1.5	16
Total Gamma	23	---	7.9 ± 0.56 μR/h	1.8	12
^{40}K	22	---	19 ± 1.4 pCi/g	4.4	31
^{238}U	---	---	0.88 ± 0.05 pCi/g	0.48	1.4
^{232}Th	22	---	0.94 ± 0.08 pci/g	0.29	1.8
^{238}Pu	7	0 - 5	0.55 ± 0.43 pCi/g	<MDA	3
	---	5 - 10	0.38 ± 0.38 pCi/g	<MDA	2.3
	---	10 - 15	0.009 ± 0.005 pCi/g	<MDA	0.03
^{239}Pu (1948)	4	0 - 2.5	1.32 ± 0.50 pCi/g	0.10	2.5
^{239}Pu (1972)	4	0 - 2.5	63 ± 63 pCi/g	0.04	255
(1972)	4	2.2 - 10	65 ± 65 pCi/g	<MDA	263
(1972)	4	10 - 30	15 ± 15 pCi/g	<MDA	62
(1973)	13	0 - 5	99 ± 84 nCi/m^2 (1.42 pCi/g)	0.3	1100
(1977)	7	0 - 5	10 ± 9 pCi/g	<MDA	65
(1977)	6	5 - 10	7.6 ± 7.3 pCi/g	<MDA	44
(1977)	7	10 - 15	29 ± 29 pCi/g	<MDA	201
^{90}Sr	4	0 - 5	1.8 ± 1.4 pCi/g	0.3	6
	4	5 - 10	0.38 ± 0.08 pCi/g	0.2	0.6
	3	10 - 15	0.70 ± 0.46 pCi/g	0.1	1.6
^{137}Cs	12	0 - 5	4.5 ± 2.3 pCi/g	0.22	27
	12	5 - 10	4.9 ± 2.6 pCi/g	<MDA	25
	10	10 - 15	0.8 ± 0.7 pCi/g	<MDA	6.3

[a]S.E. - Standard Error.

TABLE XVI

BINGHAM AREA SOIL MEASUREMENTS, US HIGHWAY 380 CORRIDOR

Radionuclide	N	Depth (cm)	Mean ± S.E.[a]	Min	Max
^{7}Be	2	---	5.8 ± 5.8 nCi/m^2	<MDA[b]	12
^{60}Co	2	---	0.6 ± 0.6 nCi/m^2	<MDA	1.2
^{137}Cs	2	---	52 ± 28 nCi/m^2	34	69
^{95}Nb	2	---	11.4 ± 0.19 nCi/m^2	1.2	1.6
Natural gamma	2	---	5.6 ± 0.2 μR/h	5.4	5.7
Total gamma	2	---	5.8 ± 0.1 μR/h	5.7	5.9
^{40}K	2	---	12 ± 0.22 pCi/g	12.1	12.6
^{232}Th	2	---	0.68 ± 0.035 pCi/g	0.64	0.71
^{238}U	2	---	0.80 ± 0.05 pCi/g	0.75	0.85
$^{239,240}Pu$ (1948)	2	0 - 1.5	0.9 ± 0.4 pCi/g	0.5	1.3
(1972)	2	0.-2.5	0.21 ± 0.08 pCi/g	0.13	0.29
(1972)	---	2.5 - 10	0.43 ± 0.32 pCi/g	0.12	0.75
(1972)	---	10 - 30	0.085 ± 0.085 pCi/g	<MDA	0.17
(1973)	14	0 - 5	5.0 ± 3.3 nCi/m^2/ (0.070 pCi/g)[c]	0.56	48

[a]S.E. - Standard Error.

[b]<MDA = less than minimum detectable activity.

[c]Calculation of the pCi/g based on 0.0143 (pCi/g)/(nCi/m^2).

factor of 3. The calculated resuspended plutonium at GZ overestimates the measured amount by a factor of 2.

Also included in Table XXIII are comparisons with both DOE and EPA air concentration limits for plutonium. The DOE air concentration limit for insoluble plutonium for an uncontrolled area is 1×10^{6} aCi/m^3 (1×10^{-12} μCi/mℓ).[28] The EPA has proposed an air concentration screening limit for no action of 1000 aCi/m^3 of transuranics from resuspension sources.[29] All measured and calculated air concentrations are well below either limit.

IV. EXTERNAL PENETRATING RADIATION

Two types of external radiation dose measurements were made for this study. The first was use of the *in situ* gamma-ray spectroscope to estimate the dose from specific radionuclides. The natural background gamma-ray spectra were summed for the uranium and thorium daughters and ^{40}K. Total external doses were calculated from the gamma-ray spectra. The dose contributions by fission and activation products such as ^{137}Cs and ^{152}Eu were estimated from their spectra. These estimates are listed in Table XXIV.

The second set of measurements was made with thermoluminescent dosimeters (TLDs) at locations on the inner and outer fences of GZ. A measurement was also made at the point of highest instrumental gamma-ray dose near the center of GZ. The locations and results of these measurements are presented in Fig. 11.

From the two sets of measurements, an estimate of the average external dose rate from the Trinity test was made for each area of the fallout zone. Table XXV lists the total measured external dose rate and the dose rate from fission and activation products. These values were used in Appendix D and Chapter 5 for estimates of the doses and the estimates of risk in the Summary, Chapter 1.

TABLE XVII

CHUPADERA MESA SURFACE SOIL MEASUREMENTS

Radionuclide	N	Depth (cm)	Mean ± S.E.[a]	Min	Max
^{7}Be	49	---	8.8 ± 1.1 nCi/m²	<MDA[b]	26
^{60}Co	49	---	0.58 ± 0.16 nCi/m²	<MDA	4.2
^{137}Cs	49	---	280 ± 30 nCi/m²	30	947
^{152}Eu[c]	49	---	0.48 ± 0.48 nCi/m²	<MDA	24
^{155}Eu	49	---	4.2 ± 2.4 nCi/m²	<MDA	86
^{95}Nb	49	---	4.65 ± 0.15 nCi/m²	<MDA	6.6
^{95}Zr	49	---	2.55 ± 0.15 nCi/m²	<MDA	4.2
^{103}Ru	49	---	0.28 ± 0.07 nCi/m²	<MDA	1.9
Natural gamma	49	---	6.7 ± 0.24 μR/h	3.5	10
Total gamma	49	---	8.2 ± 0.32 μR/h	4.1	13
^{40}K	49	---	16 ± 0.58 pCi/g	6.4	24
^{232}Th	49	---	0.85 ± 0.04 pCi/g	0.36	1.42
^{238}U	49	---	0.88 ± 0.04 pCi/g	0.34	1.81
^{238}Pu	19	0 - 5	0.083 ± 0.020 pCi/g	<MDA	0.32
	15	5 - 10	0.023 ± 0.013 pCi/g	<MDA	0.19
	15	10 - 15	0.006 ± 0.004 pCi/g	<MDA	0.06
	3	15 - 20	0.003 ± 0.003 pCi/g	<MDA	0.01
$^{239,240}Pu$ (1948)	10	0.-2.5	3.1 ± 1.3 pCi/g	<MDA	10.8
(1950)	9	0 - 2.5	3.2 ± 1.2 pCi/g	0.2	11
(1972)	3	0 - 2.5	0.80 ± 0.34 pCi/g	<MDA	1.4
(1972)	3	2.5 - 10	0.15 ± 0.10 pCi/g	0.02	0.34
(1972)	---	10 - 30	0.033 ± 0.015 pCi/g	0.01	0.06
(1973)	---	0 - 5	20.6 ± 4.3 nCi/m² (0.29 pCi/g)[d]	0.4	86
(1977)	19	0 - 5	1.7 ± 0.41 pCi/g	0.03	6.7
(1977)	14	5 - 10	0.38 ± 0.2[illegible] pCi/g	<MDA	3.9
(1977)	16	10 - 15	0.11 ± 0.07 pCi/g	<MDA	1.2
(1977)	3	15 20	0.033 ± 0.03 pCi/g	<MDA	0.09
^{90}Sr	7	0 - 5	2.3 ± 1.0 pCi/g	0.20	6.8
	3	10 - 15	0.76 ± 0.47 pCi/g	0.22	1.7
^{137}Cs	27	0 - 5	2.81 ± 0.52 pCi/g	<MDA	10.4
	4	5 - 10	0.16 ± 0.02 pCi/g	0.12	0.22
	16	10 - 15	0.04 ± 0.02 pCi/g	<MDA	0.21
	1	20 - 25	0.05	---	---

[a]S.E. - Standard Error.

[b]<MDA = less than minimum detectable activity.

[c]Forty-eight observations for ^{152}Eu were below MDA.

[d]Calculation of the pCi/g based on 0.0143 (pCi/g)/(nCi/m²).

TABLE XVIII

FAR FALLOUT ZONE SURFACE SOIL MEASUREMENTS

Radionuclide	N	Depth (cm)	Mean ± S.E.[a]	Min	Max
^{7}Be	27	---	12 ± 1.2 nCi/m^2	<MDA[b]	21
^{60}Co	27	---	0.82 ± 0.61 nCi/m^2	<MDA	16
^{137}Cs	27	---	152 ± 34 nCi/m^2	10	765
^{95}Nb	27	---	4.5 ± 0.29 nCi/m^2	<MDA	6.4
^{95}Zr	27	---	2.9 ± 0.24 nCi/m^2	<MDA	5.8
^{103}Ru	27	---	0.25 ± 0.10 nCi/m^2	<MDA	1.6
Natural gamma	26	---	8.3 ± 0.53 μR/h	3.7	15
Total gamma	26	---	8.9 ± 0.55 μR/h	4.1	16
^{40}K	27	---	19 ± 1.1 pCi/g	9.9	31
^{232}Th	27	---	1.20 ± 0.12 pCi/g	0.31	2.8
^{238}U	27	---	0.94 ± 0.05 pCi/g	0.43	1.7
^{238}Pu	12	0 - 5	0.018 ± 0.005 pCi/g	<MDA	0.06
	8	5 - 10	0.008 ± 0.005 pCi/g	<MDA	0.03
	6	10 -15	<MDA	---	---
$^{239,240}Pu$	1	0 - 2.5	0.77 pCi/g	---	---
(1950)	8	0 - 2.5	0.94 ± 0.46 pCi/g	<MDA	4.1
(1973)	24	0 - 5	3.2 ± 0.88 nCi/m^2 (0.046 pCi/g)[c]	0.32	21
(1977)	14	0 - 5	0.30 ± 0.009 pCi/g	<MDA	1.2
	9	5 - 10	0.15 ± 0.08 pCi/g	<MDA	1.5
	8	10 - 15	0.008 ± 0.005 pCi/g	<MDA	0.04
^{90}Sr	4	0 - 5	1.47 ± 0.68 pCi/g	0.71	3.5
	1	5 - 10	2.16 pCi/g	---	---
	1	10 - 15	0.30 pCi/g	---	---
	1	20 - 25	0.21 pCi/g	---	---
^{137}Cs	10	0 - 5	2.0 ± 0.19 pCi/g	0.95	3
	5	5 - 10	0.24 ± 0.19 pCi/g	<MDA	1.0
	4	10 - 15	<MDA	---	---

[a]S.E. - Standard Error.

[b]<MDA = less than minimum detectable activity.

[c]Calculation of the pCi/g is based on 0.0143 (pCi/g)/(nCi/m^2).

TABLE XIX

SAN ANTONIO AREA SURFACE SOIL MEASUREMENTS

Radionuclide	N	Depth (cm)	Mean ± S.E.[a]	Min	Max
^{7}Be	9	---	3.9 ± 2.0 nCi/m^2	<MDA[a]	14.6
^{60}Co	9	---	9.7 ± 6.0 nCi/m^2	<MDA	50
^{137}Cs	9	---	67 ± 20 nCi/m^2	<MDA	220
^{95}Nb	9	---	2.0 ± 0.3 nCi/m^2	<MDA	3.5
^{95}Zr	9	---	1.5 ± 0.33 nCi/m^2	<MDA	2.6
Natural gamma	9	---	7.5 ± 0.6 μR/h	4.5	9.9
Total gamma	9	---	7.7 ± 0.5 μR/h	5.1	9.9
^{40}K	9	---	15 ± 1.4 pCi/g	7.2	19.7
^{232}Th	9	---	0.83 ± 0.12 pCi/g	0.14	1.32
^{238}U	9	---	1.2 ± 0.13 pCi/g	0.67	2.0
$^{239,240}Pu$	4	0 - 5	0.01 ± 0.004 pCi/g	<MDA	0.02
$^{239,240}Pu$	4	5 - 10	0.003 ± 0.003 pCi/g	<MDA	0.01
$^{239,240}Pu$	4	10 - 15	<MDA	---	---

[a]S.E. - Standard Error.

[b]<MDA = less than minimum detectable activity.

TABLE XX

AREAL CONCENTRATIONS OF ^{137}Cs

Location	Mean (nCi/m^2)	Min	Max
Trinity Fallout Areas			
WSMR	8104 ± 3772	488	23 000
Bingham	52 ± 18	34	69
Chupadera Mesa	280 ± 30	30	947
Far Fallout Zone	152 ± 34	10	765
Central NM			
San Antonio	67 ± 20	<MDA	220
Other Areas of U.S.			
Amarillo, TX[a]	148 ± 32	[b]	[b]
Burlington, IA[a]	105 ± 34	[b]	[b]
Diablo Canyon, CA[c]	105	100	110
Humboldt Bay, CA[c]	32	[b]	[b]
San Clemente, CA[c]	19	8	36
La Crosse, WI[c]	139	114	164
Baxley, GA[c]	60	41	79
Daisey, TN[c]	168	146	190
Waterford, CN[c]	305	[b]	[b]

[a]See Reference 28.

[b]Single data point reported.

[c]See Reference 29.

TABLE XXI

CHUPADERA MESA IN SITU ^{137}Cs DATA FOR SOILS BY LAND FORM ($\mu Ci/m^2$)

Location	Slope Above Drainage	Closed Drainage Collection Point
Cuate Tank	388	756
	---	547
Three Peaks Area	261	947
	314	410
	---	590
Area 21	338	545
	428	512
	308	---
	428	---
High Point on Mesa	602	540
	$X_S = 383$	$X_D = 605$
	S.E. = 38	S.E. = 59

H: $X_S = X_D$

$t = -3.16$

True: <0.5% of time

False. 99.5% of time

TABLE XXII

^{90}Sr BACKGROUND INFORMATION

Location	Fallout Conc ^{90}Sr ($\mu Ci/m^2$)	1959-1976 Rainfall (cm)	Latitude and Longitude		Altitude (m)
Denver	41.21	692.73	39°46′	104°53′	1611
Salt Lake City	91.61	801.87	40°46′	110°49′	1516
El Paso	15.55	335.15	31°48′	106°48′	1204
Houston	36.40	2186.86	29°39′	95°17′	22
Dallas	40.24	1300.49	32°51′	96°51′	160
Chupadera Mesa	688	365	33°40′	105°40′	1524
	to	to	to	to	to
Far Fallout Zone	384	914	34°20′	106°30′	2450

TABLE XXIII

POTENTIAL CONTRIBUTIONS OF RESUSPENSION TO ^{239}Pu AIRBORNE RADIOACTIVITY

	^{239}Pu Concentration (aCi/m^3)	Per Cent DOE Concentration Guide	Per Cent of Proposed EPA Derived Limit[a]
Measured Airborne ^{239}Pu Concentrations			
Chupadera Mesa (10 months)[b]	43	0.0043	4.3
Soccorro (10 months)[b]	41	0.0041	4.1
GZ Average			
Center (28.7 h)[b]	63	0.0063	6.3
Mid-radius (29.8 h)[b]	3	0.0003	0.3
Entrance (34.8 h)[b]	1.2	0.00012	0.1
Control Site WSMR (37.9 h)[b]	1.1	0.00011	0.1
Calculated Contributions of Resuspension to ^{239}Pu Airborne Concentrations			
GZ	38	0.0038	3.8
White Sands Fallout Area	22	0.0022	2.2
Bingham	7	0.0007	0.7
Chupadera Mesa	120	0.012	12
Far Fallout Zone	22	0.0022	2.2
Range of ^{239}Pu from Worldwide Fallout, 1974-1978, at Santa Fe, NM			
Low (1976)	3.8	0.006	0.4
5-Year Average	16	0.03	1.6
High (1978)	24	0.04	2.4

[a]See Table XXVI.
[b]Sample time.

TABLE XXIV

EXTERNAL RADIATION EXPOSURE SUMMARY FOR IN SITU DATA

White Sands South of GZ (Los Alamos National Laboratory Control) 3 Miles South		
	Due to Natural	9.3 ± 0.17 μR/h
	Total External	9.8 ± 0.23 μR/h
GZ		
	Due to Natural	5.6 ± 0.5 μR/h
	Total External	175 ± 1.1 μR/h
	^{137}Cs	9.9 ± 0.15 μR/h
	^{152}Eu	137 ± 0.7 μR/h
White Sands Missile Range in Fallout Path		
	Due to Natural	8.1 ± 0.26 μR/h
	Total External	22 ± 0.3 μR/h
	^{137}Cs	1.8 ± 0.03 μR/h
	Others: ^{60}Co, ^{152}Eu, ^{154}Eu	13.1 μR/h
Chupadera Mesa, Area 21, Los Alamos National Laboratory Study Area 30 miles from GZ)		
	Due to Natural	6.0 ± 0.14 μR/h
	Total External	8.1 ± 0.14 μR/h
	^{137}Cs	2.0 ± 0.03 μR/h
Monte Puerto Ranch		
	Due to Natural	8.2 ± 0.13 μR/h
	Total External	9.8 ± 0.14 μR/h
	^{137}Cs	1.5 ± 0.02 μR/h
Far Fallout Zone (~55 miles NE from GZ)		
	Due to Natural	6.8 ± 0.28 μR/h
	Total External	7.5 ± 0.28 μR/h

TABLE XXV

EXTERNAL PENETRATING RADIATION MEASUREMENTS AND ESTIMATES OF CONTRIBUTIONS FROM TRINITY FALLOUT

(μrem/h)

Location	Measurement	Estimated Contribution Above Background
GZ		
Center Maximum	485 ± 4	477
Inner Fence	205 ± 61	187
Outer Fence	10.8 ± 2.5	3.1
White Sands Missile Range	7.8 ± 0.6	0.1
Bingham	5.8 ± 0.1	0.2
Chupadera Mesa	8.2 ± 0.32	1.5
Far Fallout Zone	8.9 ± 0.55	0.6

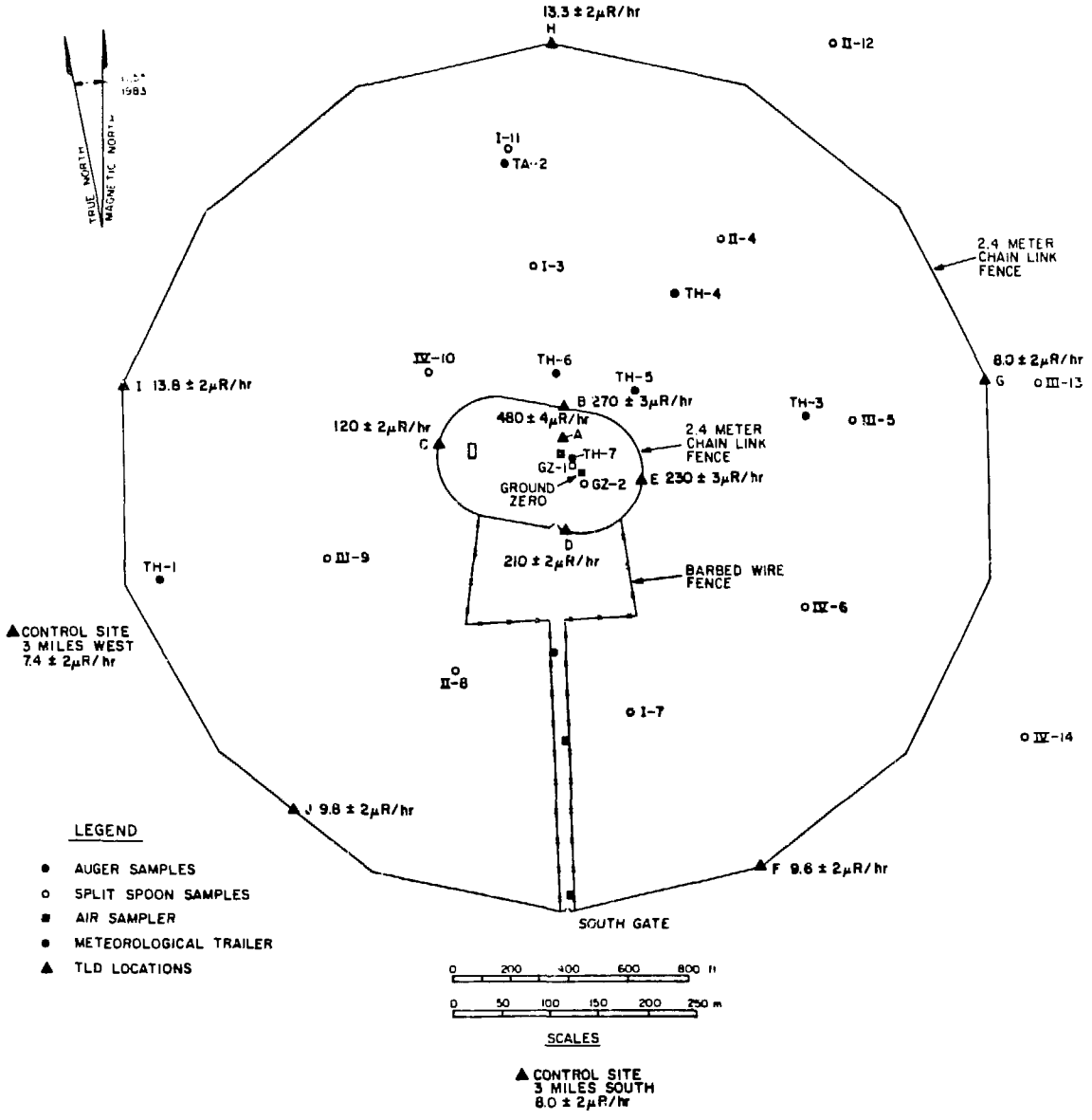

Fig. 11. External radiation dose rates measured at Trinity Site, June 9, 1983 to June 23, 1983.

5. POTENTIAL DOSE EVALUATION AND INTERPRETATION

The significance of the data on concentrations of radioactivity on soils and sediments, radioactivity on airborne particulates, and external penetrating radiation may be evaluated in terms of the doses that can be received by people exposed to the conditions. The doses can be compared with natural background and appropriate standards or guides for one type of perspective. The doses can also be used to estimate risks or probabilities of health effects to an individual, providing another type of perspective more readily compared with other risks encountered. This section summarizes the analysis of potential doses and risk estimates. The detailed analysis is presented in Appendix D. Readers desiring more information on concepts of radioactivity, radiation, and dose interpretation may be helped by Appendix E, Evaluation of Radiation Exposures.

I. BASES OF DOSE ESTIMATES AND COMPARISONS

Doses were calculated for various pathways that could result in the inhalation or ingestion of radioactivity. The calculations were based on theoretical models or factors from standard references and health physics literature as detailed in Appendix D. The doses are expressed in fractions of rems, where a millirem (mrem) is 1/1000 of a rem, and a microrem (μrem) is 1/1 000 000 of a rem. They are generally expressed as dose rates, that is, the radiation dose received in a particular time interval. The rem is a unit that permits direct comparison of doses from different sources, such as x rays, gamma rays, and alpha particles, by accounting for the differences in biological effects from the energy absorbed from different radiations and isotope distributions. These doses can be compared with the DOE Radiation Protection Standards shown in Table XXVI, which are expressed as the permissible dose or dose commitment in addition to natural background radiation and medical exposures. First-year doses represent the dose received during the first year that a given radioactive isotope is ingested or inhaled. Because most of the isotopes of concern in this study are retained in various organs in the body for more than a year, 50-year dose commitments were also calculated. The 50-year dose commitments represent the total dose that would be accumulated in the body or specific critical organs over a 50-year period from ingestion or inhalation during the first year. (Alternatively, the numerical values can also be interpreted to represent the annual dose rate during the 50th year given continuous exposure over all 50 years.) The 50-year commitments are always as large or larger than first-year doses. In this summary, only the 50-year commitments are compared with the standards.

Conceptually, this is in agreement with the recommendations of the International Commission on Radiological Protection (ICRP) that in effect charge the entire dose commitment against the year in which exposure occurs for regulatory purposes.[30] The use of the 50-year dose commitment also permits making estimates of risk over a lifetime from the given exposure and simplifies comparisons between different exposure situations.

The dose commitments were calculated using published factors (Appendix D). The dose models employed in the derivation of these factors are based primarily upon reports of the ICRP. Other methods of computing doses are available. Additionally, there are conceptually different approaches emphasizing the dose at the time of maximum dose rate following exposure as the basis for comparison with standards.[31-33] This is significant for isotopes such as plutonium that accumulate in certain parts of the body and can lead to a constantly increasing dose rate under conditions of chronic exposure. One such approach has been proposed by the EPA as guidance for Federal agencies in regard to plutonium.[29] These other approaches do not yield dose estimates or comparisons with standards sufficiently different from the methods used in this report to make any significant difference in the conclusions drawn for the radionuclides of concern in this evaluation. For example, under conditions of chronic exposure to airborne ^{239}Pu, the radiation dose in the year of maximum dose rate (taken to be the 70th year) calculated by the methods of Healy or the EPA would give organ-specific estimates ranging from about 1/4 (for bone) to 2.6 (for lung) times the values given in this

TABLE XXVI

STANDARDS AND GUIDES FOR RADIATION AND RADIOACTIVITY

DOE Radiation Protection Standards for External and Internal Exposures[a]

Individuals and Population Groups in Uncontrolled Areas

Type of Exposure	Annual Dose Equivalent or Dose Commitment[b]	
	Based on Dose to Individuals at Points of Maximum Probable Exposure	Based on an Average Dose to a Suitable Sample of the Exposed Population
Whole body, gonads, or bone marrow	0.5 rem (or 500 mrem)	0.17 rem (or 170 mrem)
Other organs	1.5 rem (or 1500 mrem)	0.5 mrem (or 500 mrem)

DOE Concentration Guides for Radioactivity in Air and Water Above Natural Background in Uncontrolled Areas[c]

Isotope	Media	Concentration	
		In Units of Original Reference	In Units Used in This Report
^{239}Pu	Water	5×10^{-6} μCi/mℓ	5000 pCi/ℓ
^{239}Pu	Air	6×10^{-14} μCi/mℓ	60 000 aCi/m^3

EPA Maximum Contaminant Levels from Natural Interim Primary Drinking Water Regulations[d]

Isotope	Media	Concentration
Gross Alpha (including ^{226}Ra but excluding radon and uranium)	Water	15 pCi/ℓ

TABLE XXVI (cont)

EPA Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment[a]

Maximum Annual Alpha Radiation Dose Rate as Result of Exposure to Transuranium Elements:

1 mrad/yr to pulmonary lung	(approximately 10 mrem/yr)
3 mrad/yr to bone	(approximatley 150 mrem/yr)

Derived Air Concentration Reasonably Predicted to Result in Dose Rates Less than the Guidance Recommendations:

In Units of Original Reference	In Units Used in This Report
1 fCi/m^3	1000 aCi/m^3

(for alpha emitting transuranium nuclides on an activity median aerodynamic particle diameter not to exceed 0.1 μm)

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[a]See Reference 29.
[b]To meet the above dose commitment standards, operations must be conducted in such a manner that it would be unlikely that an individual would assimulate in a critical organ, by inhalation, ingestion, or absorption, a quantity of a radionuclide(s) that would commit the individual to an organ dose exceeding the limits specified in the above table.
[c]See Reference 29.
[d]See Reference 30.
[e]See Reference 18.

report.[33,31] These factors are about the same size as other uncertainties in the data (see Chapter 4.I.A) and smaller than some of the intentionally overestimated assumptions incorporated in this evaluation. Thus there would be no significant changes in the relative ranking or order of magnitude of estimated doses and risks if other methodologies were used.

The estimates of radiological risks from doses, presented in Table I of the summary chapter, were based on the risk factors recommended by the National Academy of Sciences.[34] Multiplying an estimated dose and the appropriate risk factor yields an estimate of the probability of injury to the individual as a result of that exposure. The risk factors used are

For uniform whole-body dose	
Cancer mortality	1.2×10^{-4} per rem whole body,
For specific organ doses	
Lung cancer	9×10^{-5} per rem to lung,
Bone cancer	3×10^{-6} per rem to bone,
Liver cancer	3×10^{-5} per rem to liver.

As an example, a whole-body dose of 10 mrem/yr (1.2×10^{-2} rem/yr) would be estimated to add a risk of cancer mortality to the exposed individual of 1.2×10^{-6} per year of exposure, or about 1 chance in 1 000 000 per year of exposure.

Such risk estimates must be placed in appropriate contexts to be useful as a decision-making tool. One comparison is with other types of risks encountered in normal life that may result in early mortality. Table II (in Chapter 1) of this report presented a range of selected examples of activities and risks that increase chances of death.[35,36] A second useful comparison is an estimate of the risk that can be attributed to natural background radiation. Radiation from various natural external and internal sources results in exactly the same types of interactions with body tissues as those from so-called "manmade" radioactivity. Thus, the risks from a given dose are the same regardless of the source.

Natural background radiation for people in the environment consists of the external penetrating dose from cosmic and terrestrial sources, cosmic neutron radiation, and self-irradiation from natural isotopes in the body. The several-year average for external penetrating radiation measured by a group of 12 perimeter stations located mainly in the Los Alamos area of New Mexico is about 117 mrem/yr. Cosmic neutrons contribute about 17 mrem/yr, and average self-irradiation, largely from natural radioactive potassium (^{40}K), is about 24 mrem/yr. These give a combined dose of about 158 mrem/yr. Because of the variations in the terrestrial component with location and time of year, this value is probably valid to about ±25% for most of the Los Alamos population. For purposes of comparison we will use a rounded value of 150 mrem/yr as typical natural background in the area. This can be interpreted, using the risk factors, to represent a contribution to the risk of cancer mortality of 1.8×10^{-5} (18 chances in 1 000 000) for each year of exposure or a risk of 9×10^{-4} (9 chances in 10 000) in 50 years of exposure to natural background radiation. The natural radiation combined dose for external penetrating dose, cosmic neutron dose, and self-irradiation from internally deposited radionuclides is estimated to be 106 mrem/yr for persons living in the Far Fallout Zone. This would represent a contribution to the risk of cancer mortality of 1.3×10^{-5} (18 chances in 1 000 000) for each year of exposure or a risk of 6×10^{-4} (6 chances in 10 000) in 50 years of exposure to natural background in that area. As perspective, estimates of the overall U.S. population lifetime risk of mortality from cancer induced by all causes are currently about 0.2 (2 chances in 10.)

II. POTENTIAL DOSES FROM THE CURRENT CONDITIONS IN THE TRINITY TEST FALLOUT DEPOSITION AREAS

The dose calculations made from the summary data in Chapter 4 are detailed in Appendix D. The overall summary of Appendix D dose estimates is presented in Table XXVII along with the DOE Radiation Protection Standards for whole-body and organ exposures. Also listed is the proposed Environmental Protection Agency (EPA) guidance for transuranic elements in the environment, expressed in mrem/yr. Comparison of the estimated inhalation and ingestion doses with the DOE and EPA guidance indicates there is no cause for concern for individuals living full time in the uncontrolled areas of the fallout zone. However, the controlled GZ fenced areas still have enough residual radiation to exceed standards for uncontrolled areas; but the levels are less than the 5000 mrem/yr standard for controlled areas.

The controlled areas of the fenced GZ are within the larger controlled access area of White Sands Missile Range (Fig. 4). The fence around GZ is locked, with access controlled by the Army's Range Safety Officer and by Security. Public access is limited to a 2-h visit in the autumn of each year when the site is opened to visitors. Visitors are escorted to the site and back off the White Sands Missile Range. The dose to any member of the public would be less than 1 mrem during such a visit.

Other possible means of exposure involve Army personnel either as workers preparing for visitors or the daily security patrols that pass the GZ area outside the fence. Assuming personnel spend 1 week in the inner fenced area in preparation for visitors, the estimated dose would be about 8 mrem total dose. Assuming the security patrol spends 1 hour per day all year checking the outer fence, the estimated dose is 0.75 mrem. These doses are 1.6% and 0.2%, respectively, of the radiation protection standard for a member of the public.

III. SPECIAL CONSIDERATIONS

The GZ area of White Sands Missile Range was declared a National Historic Site in 1962. Any actions considered that alter current conditions will require consultation with the U.S. Army and National Historic Preservation Council of the U.S. Department of the Interior.

TABLE XXVII

INCREMENTAL DOSES

Location	Mean *External* Whole Body Increment above Natural Background (mrem/yr)	*mrem/yr (50-Year Committed Dose)*											
		Inhalation Total from Resuspension[a]				Ingestion Total from Foods[b]				Inhalation of Dust by Home Gardener[a]			
		Whole Body	Bone	Lung	Liver	Whole Body	Bone	Liver	GI-LLI	Whole Body	Bone	Lung	Liver
GZ													
Inner fence[c]	17	0.028	0.29	0.30	0.14	2.4	74	35	1.3	0.11	1.2	1.2	0.59
Between fences[c]	876	0.0073	0.074	0.077	0.037	0.1	2.7	1.3	0.03	0.017	0.17	0.18	0.086
White Sands Missile Range[c]102	14	0.016	0.17	0.17	0.083	1.7	20	2.9	1.3	0.073	0.76	0.80	0.38
Bingham	1.7	0.0049	0.051	0.053	0.025	1.6	19	2.3	1.2	0.039	0.40	0.42	0.20
Chupadera Mesa	13	0.088	0.91	0.95	0.45	1.9	37	8.1	1.5	0.083	0.86	0.87	0.42
Far Fallout Zone	5	0.016	0.17	0.17	0.083	1.2	16	1.8	1.0	0.017	0.19	0.17	0.086
San Antonio	1.7	0.00058	0.0056	0.0058	0.0028	0.1	0.2	0.2	0.05	d	d	d	d
Radiation Protection Standard	500	500	1500	1500	1500	500	1500	1500	1500	500	1500	1500	1500
EPA Proposed Guidance	---	---	150	10	---	---	---	---	---	---	150	10	---

[a]Major dose contributed by transuranics.
[b]*Major dose contributed by transuranics and* ^{90}Sr (see Appendix D, Table D-XII).
[c]Equal time spent at high-dose rate and low-dose rate areas. Assumes 168 h/wk, 52 wk occupancy.
[d]Not calculated because other *inhalation doses are small.*

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ALO	Albuquerque Operations Office
c	counts
cpm	counts per minute
CG	concentration guide
DOE	Department of Energy
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
FDA	Food and Drug Administration
FSD	Fractional Standard Deviation
FUSRAP	Formerly Utilized Sites Remedial Action Program
GZ	Ground Zero
ICRP	International Commission on Radiological Protection
LADB	Los Alamos Data Base
MDA	Minimum Detectable Activity
MED	Manhattan Engineer District
NCRP	National Council on Radiation Protection and Measurements
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
QA	quality assurance
RCG	Radioactivity Concentration Guide
rem	roentgen equivalent man
RPS	Radiation Protection Standard
TLD	thermoluminescent dosimeter
TRU	transuranic
TSS	total suspended solids
USGS	United States Geological Survey
WSMR	White Sands Missile Range

α	alpha
β	beta
γ	gamma
s	standard deviation
$\bar{x}$	mean

UNITS

Abbreviation	Unit
c	count
aCI	attocurie (10^{-18} curies)
Ci	curie (unit of radioactivity)
cm	centimeter
cpm/ℓ	counts per min per liter
fCi	femtocurie (10^{-15} curies)
ft	foot
g	gram
h	hour
in.	inch
keV	kiloelectron volt
kg	kilogram
km	kilometer
km^2	square kilometer
ℓ	liter
m	meter
m^3	cubic meter
mCi	millicurie (10^{-3} curies)
MeV	megaelectron volt
mg	milligram (10^{-3} grams)
min	minute
mℓ	milliliter (10^{-3} ℓ)
mm	millimeter (10^{-3} meter)
mrem	millirem (10^{-3} rem)
mS/m	milliSiemens/meter (1 mS/m = 10 μmho/cm)
MGD	million gallons per day
MT	megaton (10^6 tons)
μCi	microcurie (10^{-6} curies)
μg	microgram (10^{-6} grams)
μm	micrometer (10^{-6} meters)
nCi	nanocurie (10^{-9} curies)
pCi	picocurie (10^{-12} curies)
R	Roentgen
rad	62.5×10^6 MeV/g (unit of absorbed dose)
rem	roentgen equivalent man (unit of dose equivalence)
s	second
yr	year

GLOSSARY

alpha particle	A charged particle (identical to the helium nucleus) composed of two protons and two neutrons that is emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.
beta particle	A charged particle (identical to the electron) that is emitted during decay of certain radioactive atoms. Most beta particles are stoppped by 0.6 cm of aluminum or less.
CG (Concentration Guide)	The concentration of radioactivity in air or water that is determined to result in whole-body or organ doses equal to ERDA's Radiation Protection Standards for external and internal exposures if the air is continuously inhaled or the water is the sole source of liquid nourishment throughout the year.
Curie	A special unit of radioactivity. One curie equals 3.70×10^{10} nuclear transformations per second (abbreviated Ci).
gamma radiation (or x radiation)	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength, gamma radiation can cause ionization. Other electromagnetic radiation (microwaves, visible light, radiowaves, etc.) has longer wavelengths (lower energy) and cannot cause ionization.
arithmetic mean	The average of n given numbers obtained by dividing their sum by n.
geometric mean	The average of n given numbers obtained as the nth root of their product.
gross alpha	The total amount of measured alpha activity.
gross beta	The total amount of measured beta activity.
rad	The unit of absorbed radiation dose. It applies to the fraction of energy deposited by ionizing radiation in a unit volume of material exposed. 1 Rad = 1×10^{-2} Joules per kilogram.
roentgen	The unit of radiation exposure (abbreviated R). It applies only to the amount of charge produced by x or gamma radiation in air. 1 R = 2.58×10^{-4} coulombs per kilogram.

rem	The unit of radiation dose equivalence that takes into account different effects on humans of various kinds of ionizing radiation and permits them to be expressed on a common basis.
RPS (Radiation Protection Standard)	DOE standards for external and internal exposure to radioactivity as defined in DOE Order 5480.
total uranium	Uranium having the isotopic content of uranium in nature (99.27% ^{238}U, 0.72% ^{235}U, 0.0057% ^{234}U).

APPENDIX A

DATA BASE TRINDAT

The following computer printout contains the combined data from the several studies of environmental levels of radioactivity through 1977. The printout contains 10 columns of information regarding each sample. The following provides a key to the information in each column:

Column 1—Sample number. "Tag Words" are discussed in Appendix B. The sample numbers greater than 1000 are for a given location from the 1977 survey. Appendix B is a field log describing each location.

Column 2—Radionuclide analyzed for in the sample or type of radiation measured (G-NAT = natural gamma dose).

Column 3—Date of the determination.

Column 4—Type of Sample.

INSITU—Field *in situ* gamma-ray spectroscopy by Lawrence Livermore Laboratory system.
JP—one-seeded juniper
GR—grasses
SK—snakeweed
TH—Thistle
UK—Unknown vegetation
SG—mixed snakeweed and grasses
SOIL—Soil sample. Column 5 contains information on depth.

Column 5—Midpoint of depth from surface of soil samples. Examples: 2.5 is for 0- to 5-cm sample; 7.5 is for 5- to 10-cm sample, and 12.5 is for 10- to 15-cm sample.

Columns 6 and 7—Arbitrary coordinates from a base map of sample locations. Used for computer graphics in Chapter 4.

Column 8—Value of radionuclide concentration or penetrating radiation dose.

Column 9—Units for amount of radionuclide or radiation dose.

Column 10—Laboratory or agency that conducted determination:

LASL77—Now Los Alamos National Laboratory; associated with *in situ* determinations.

LLL GELI—Samples counted at Lawrence Livermore National Laboratory.

LASLCHEM—Sample determination made by Los Alamos National Laboratory Environmental Surveillance Chemistry Section.

CVEG—Vegetation content by same group as LASLCHEM.

EPA—Environmental Protection Agency determination.

UCLA—University of California at Los Angeles studies of 1948 and 1950.

LASL72—Samplings by Los Alamos Scientific Laboratory in 1972.

With the large amount of data present in TRINDAT, much more information than covered by this report can be recovered from the data base. The last item to be identified is the label associated with PU239 as INSITU in Column 4 and PREDICTED in Column 10. Those data were calculated from known amounts of ^{137}Cs *in situ* measurements and $^{239\text{-}240}Pu$ soil samples at a number of locations. Both ^{137}Cs and plutonium isotopes are

strongly retained in the top few centimeters of soils. If there were a strong correlation between ^{137}Cs and $^{239-240}Pu$ in soils, a few $^{239-240}Pu$ radiochemical determinations could establish the relationship with ^{137}Cs. Determination of ^{137}Cs by relatively inexpensive *in situ* measurements could be used for $^{239-240}Pu$ estimates at other sampling points in large areas. The "predicted" data in TRINDAT were not used for any of the estimates in this report, but the method has enough promise to merit further development in the future.

TRINDAT

2018	BE7	1977	GR	5.66	1.76	8.98	PCI/GM LLL GELI
2055	BE7	1977	GR	11.35	5.86	20.39	PCI/GM LLL GELI
1990	BE7	1977	GR	6.64	.55	8.72	PCI/GM LLL GELI
1988	BE7	1977	GR	6.64	.55	4.98	PCI/GM LLL GELI
2018	BE7	1977	INSITU	6.66	1.76	9.68	NCI/M2 LASL77
2096	BE7	1977	INSITU	14.49	9.24	21.10	NCI/M2 LASL77
2016	BE7	1977	INSITU	7.24	2.33	0.00	NCI/M2 LASL77
2099	BE7	1977	INSITU	11.12	10.93	12.10	NCI/M2 LASL77
2139	BE7	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2153	BE7	1977	INSITU	3.94	4.88	0.00	NCI/M2 LASL77
2141	BE7	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2015	BE7	1977	INSITU	7.37	2.31	6.47	NCI/M2 LASL77
2075	BE7	1977	INSITU	10.85	4.60	14.30	NCI/M2 LASL77
2127	BE7	1977	INSITU	13.40	5.21	18.50	NCI/M2 LASL77
2029	BE7	1977	INSITU	10.35	4.28	9.83	NCI/M2 LASL77
2121	BE7	1977	INSITU	13.68	6.87	0.00	NCI/M2 LASL77
2031	BE7	1977	INSITU	10.41	4.28	19.40	NCI/M2 LASL77
2072	BE7	1977	INSITU	9.86	4.42	0.00	NCI/M2 LASL77
2100	BE7	1977	INSITU	14.50	12.20	17.30	NCI/M2 LASL77
2140	BE7	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2147	BE7	1977	INSITU	7.77	3.07	11.65	NCI/M2 LASL77
2155	BE7	1977	INSITU	3.91	3.49	0.00	NCI/M2 LASL77
2142	BE7	1977	INSITU	6.27	.00	9.08	NCI/M2 LASL77
2032	BE7	1977	INSITU	3.17	3.48	9.78	NCI/M2 LASL77
1997	BE7	1977	INSITU	6.46	1.16	0.00	NCI/M2 LASL77
2132	BE7	1977	INSITU	6.70	2.16	7.74	NCI/M2 LASL77
2128	BE7	1977	INSITU	13.77	5.47	9.79	NCI/M2 LASL77
2076	BE7	1977	INSITU	11.09	4.52	14.70	NCI/M2 LASL77
2062	BE7	1977	INSITU	9.83	5.10	9.90	NCI/M2 LASL77
2090	BE7	1977	INSITU	13.85	7.69	0.00	NCI/M2 LASL77
2030	BE7	1977	INSITU	10.39	[illegible]	0.00	NCI/M2 LASL77
2138	BE7	1977	INSITU	5.81	2.[illegible]	11.49	NCI/M2 LASL77
2136	BE7	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2059	BE7	1977	INSITU	9.74	5.42	16.10	NCI/M2 LASL77
2008	BE7	1977	INSITU	7.40	2.10	0.00	NCI/M2 LASL77
2134	BE7	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2095	BE7	1977	INSITU	14.49	9.25	14.00	NCI/M2 LASL77
2129	BE7	1977	INSITU	6.27	0.00	0.00	NCI/M2 LASL77
2067	BE7	1977	INSITU	9.31	4.96	0.00	NCI/M2 LASL77
2077	BE7	1977	INSITU	10.31	4.41	12.12	NCI/M2 LASL77
2061	BE7	1977	INSITU	9.91	5.07	13.40	NCI/M2 LASL77
2025	BE7	1977	INSITU	10.12	4.27	0.00	NCI/M2 LASL77
2094	BE7	1977	INSITU	14.49	9.25	14.30	NCI/M2 LASL77
2068	BE7	1977	INSITU	9.30	5.02	0.00	NCI/M2 LASL77
2074	BE7	1977	INSITU	9.85	4.35	16.60	NCI/M2 LASL77
2050	BE7	1977	INSITU	11.11	5.55	0.00	NCI/M2 LASL77
2126	BE7	1977	INSITU	12.45	4.27	17.70	NCI/M2 LASL77
2048	BE7	1977	INSITU	11.09	5.87	12.80	NCI/M2 LASL77
2146	BE7	1977	INSITU	9.82	4.27	12.12	NCI/M2 LASL77
2038	BE7	1977	INSITU	9.60	4.32	12.52	NCI/M2 LASL77
2088	BE7	1977	INSITU	13.22	7.66	13.90	NCI/M2 LASL77
2011	BE7	1977	INSITU	6.32	.00	13.40	NCI/M2 LASL77
2006	BE7	1977	INSITU	7.07	2.04	0.00	NCI/M2 LASL77
2058	BE7	1977	INSITU	10.00	5.31	14.00	NCI/M2 LASL77
2081	BE7	1977	INSITU	11.31	7.21	11.80	NCI/M2 LASL77
2034	BE7	1977	INSITU	3.16	3.70	0.00	NCI/M2 LASL77
2097	BE7	1977	INSITU	15.45	9.75	11.49	NCI/M2 LASL77
2125	BE7	1977	INSITU	14.68	4.45	16.07	NCI/M2 LASL77
2093	BE7	1977	INSITU	14.60	8.57	0.00	NCI/M2 LASL77
2020	BE7	1977	INSITU	3.17	3.48	0.00	NCI/M2 LASL77
2053	BE7	1977	INSITU	10.69	5.56	14.20	NCI/M2 LASL77
2024	BE7	1977	INSITU	8.95	3.88	0.00	NCI/M2 LASL77
2083	BE7	1977	INSITU	12.14	7.19	15.30	NCI/M2 LASL77
2019	BE7	1977	INSITU	6.69	2.24	8.53	NCI/M2 LASL77
2135	BE7	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2052	BE7	1977	INSITU	11.11	5.55	10.80	NCI/M2 LASL77
2014	BE7	1977	INSITU	7.37	2.22	18.80	NCI/M2 LASL77
2120	BE7	1977	INSITU	14.30	7.16	14.50	NCI/M2 LASL77
2047	BE7	1977	INSITU	11.08	5.74	11.69	NCI/M2 LASL77
2114	BE7	1977	INSITU	10.46	7.18	0.00	NCI/M2 LASL77
2065	BE7	1977	INSITU	10.39	5.01	20.30	NCI/M2 LASL77
2013	BE7	1977	INSITU	7.43	2.11	0.00	NCI/M2 LASL77
2130	BE7	1977	INSITU	6.03	.60	0.00	NCI/M2 LASL77
2082	BE7	1977	INSITU	11.62	7.18	14.50	NCI/M2 LASL77
2073	BE7	1977	INSITU	9.86	4.42	0.00	NCI/M2 LASL77
2119	BE7	1977	INSITU	14.34	7.21	14.93	NCI/M2 LASL77
2080	BE7	1977	INSITU	10.91	7.22	13.20	NCI/M2 LASL77
2027	BE7	1977	INSITU	10.28	4.20	16.20	NCI/M2 LASL77
2064	BE7	1977	INSITU	10.54	7.19	14.10	NCI/M2 LASL77
2023	BE7	1977	INSITU	9.54	3.98	11.50	NCI/M2 LASL77

2144	BE7	1977	INSITU	10.46	7.19	9.87	NCI/M2	LASL77
2039	BE7	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
2009	BE7	1977	INSITU	6.59	1.65	12.20	NCI/M2	LASL77
2148	BE7	1977	INSITU	2.98	3.62	10.39	NCI/M2	LASL77
2033	BE7	1977	INSITU	3.14	3.57	0.00	NCI/M2	LASL77
2017	BE7	1977	INSITU	7.25	2.33	0.00	NCI/M2	LASL77
1998	BE7	1977	INSITU	6.63	.55	0.00	NCI/M2	LASL77
2085	BE7	1977	INSITU	12.60	6.58	13.90	NCI/M2	LASL77
2118	BE7	1977	INSITU	14.55	6.45	19.00	NCI/M2	LASL77
2037	BE7	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77
2071	BE7	1977	INSITU	9.83	4.48	17.50	NCI/M2	LASL77
2101	BE7	1977	INSITU	16.52	14.74	13.10	NCI/M2	LASL77
2079	BE7	1977	INSITU	10.53	7.20	16.20	NCI/M2	LASL77
2115	BE7	1977	INSITU	13.57	6.49	13.40	NCI/M2	LASL77
2092	BE7	1977	INSITU	13.52	9.21	12.70	NCI/M2	LASL77
2042	BE7	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77
2066	BE7	1977	INSITU	10.60	4.42	0.00	NCI/M2	LASL77
2049	BE7	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2043	BE7	1977	INSITU	3.91	3.49	0.00	NCI/M2	LASL77
2055	BE7	1977	INSITU	11.35	5.86	0.00	NCI/M2	LASL77
2154	BE7	1977	INSITU	3.95	4.57	14.60	NCI/M2	LASL77
2022	BE7	1977	INSITU	9.60	4.32	13.60	NCI/M2	LASL77
1996	BE7	1977	INSITU	6.45	.75	7.89	NCI/M2	LASL77
2086	BE7	1977	INSITU	10.53	7.19	0.00	NCI/M2	LASL77
2028	BE7	1977	INSITU	10.37	4.33	25.90	NCI/M2	LASL77
2084	BE7	1977	INSITU	12.58	7.17	13.20	NCI/M2	LASL77
2131	BE7	1977	INSITU	6.62	1.87	7.98	NCI/M2	LASL77
2012	BE7	1977	INSITU	6.79	1.77	12.10	NCI/M2	LASL77
2010	BE7	1977	INSITU	6.79	1.71	0.00	NCI/M2	LASL77
2060	BE7	1977	INSITU	9.91	5.07	0.00	NCI/M2	LASL77
2143	BE7	1977	INSITU	4.81	3.00	0.00	NCI/M2	LASL77
2026	BE7	1977	INSITU	10.05	4.07	20.80	NCI/M2	LASL77
2122	BE7	1977	INSITU	13.69	6.87	0.00	NCI/M2	LASL77
2040	BE7	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
2123	BE7	1977	INSITU	13.68	6.79	0.00	NCI/M2	LASL77
2087	BE7	1977	INSITU	12.92	7.66	14.40	NCI/M2	LASL77
2116	BE7	1977	INSITU	13.74	6.12	17.90	NCI/M2	LASL77
2041	BE7	1977	INSITU	9.61	4.32	0.00	NCI/M2	LASL77
2057	BE7	1977	INSITU	10.35	5.34	13.40	NCI/M2	LASL77
2007	BE7	1977	INSITU	7.10	2.07	0.00	NCI/M2	LASL77
2049	BE7	1977	SG	11.11	5.55	7.47	PCI/GM	LLL GELI
1991	BE7	1977	SK	6.63	.55	2.47	PCI/GM	LLL GELI
2007	BE7	1977	SK	7.10	2.07	10.60	PCI/GM	LLL GELI
2045	BE7	1977	SK	10.52	5.51	7.56	PCI/GM	LLL GELI
1987	BE7	1977	SK	6.63	.55	3.54	PCI/GM	LLL GELI
2016	BE7	1977	SK	7.24	2.33	9.23	PCI/GM	LLL GELI
2028	BE7	1977	TH	10.37	4.33	0.00	PCI/GM	LLL GELI
2052	BE7	1977	UK	11.11	5.55	5.77	PCI/GM	LLL GELI
1990	CO60	1977	GR	6.64	.55	0.00	PCI/GM	LLL GELI
1988	CO60	1977	GR	6.64	.55	.31	PCI/GM	LLL GELI
2055	CO60	1977	GR	11.35	5.86	.36	PCI/GM	LLL GELI
2018	CO60	1977	GR	6.66	1.76	.33	PCI/GM	LLL GELI
2140	CO60	1977	INSITU	6.58	.55	6100.00	NCI/M2	LASL77
2039	CO60	1977	INSITU	9.60	4.32	1.70	NCI/M2	LASL77
2139	CO60	1977	INSITU	6.58	.55	11.41	NCI/M2	LASL77
2047	CO60	1977	INSITU	11.08	5.74	0.00	NCI/M2	LASL77
2135	CO60	1977	INSITU	6.58	.55	19300.00	NCI/M2	LASL77
2143	CO60	1977	INSITU	4.81	3.00	1.22	NCI/M2	LASL77
2018	CO60	1977	INSITU	6.66	1.76	0.00	NCI/M2	LASL77
2028	CO60	1977	INSITU	10.37	4.33	2.50	NCI/M2	LASL77
2016	CO60	1977	INSITU	7.24	2.33	0.00	NCI/M2	LASL77
2011	CO60	1977	INSITU	6.32	.00	0.00	NCI/M2	LASL77
2034	CO60	1977	INSITU	3.16	3.70	3.18	NCI/M2	LASL77
2086	CO60	1977	INSITU	10.53	7.19	0.00	NCI/M2	LASL77
2147	CO60	1977	INSITU	7.77	3.07	0.00	NCI/M2	LASL77
2019	CO60	1977	INSITU	6.69	2.24	0.00	NCI/M2	LASL77
2144	CO60	1977	INSITU	10.46	7.19	0.00	NCI/M2	LASL77
2007	CO60	1977	INSITU	7.10	2.07	0.00	NCI/M2	LASL77
2084	CO60	1977	INSITU	12.58	7.17	0.00	NCI/M2	LASL77
2050	CO60	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2080	CO60	1977	INSITU	10.91	7.22	0.00	NCI/M2	LASL77
2148	CO60	1977	INSITU	2.98	3.62	0.00	NCI/M2	LASL77
2083	CO60	1977	INSITU	12.14	7.19	0.00	NCI/M2	LASL77
2059	CO60	1977	INSITU	9.74	5.42	0.00	NCI/M2	LASL77
2077	CO60	1977	INSITU	10.31	4.41	1.20	NCI/M2	LASL77
2041	CO60	1977	INSITU	9.61	4.32	1.94	NCI/M2	LASL77
2136	CO60	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2026	CO60	1977	INSITU	10.05	4.07	2.74	NCI/M2	LASL77
2155	CO60	1977	INSITU	3.91	3.49	0.00	NCI/M2	LASL77
2017	CO60	1977	INSITU	7.25	2.33	0.00	NCI/M2	LASL77

2094	C060	1977	INSITU	14.49	9.25	0.00	NCI/M2	LASL77
2071	C060	1977	INSITU	9.83	4.48	0.00	NCI/M2	LASL77
2120	C060	1977	INSITU	14.30	7.16	0.00	NCI/M2	LASL77
2029	C060	1977	INSITU	10.35	4.28	0.00	NCI/M2	LASL77
2025	C060	1977	INSITU	10.12	4.27	4.23	NCI/M2	LASL77
2141	C060	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2095	C060	1977	INSITU	14.49	9.25	0.00	NCI/M2	LASL77
2115	C060	1977	INSITU	13.57	6.49	0.00	NCI/M2	LASL77
2119	C060	1977	INSITU	14.34	7.21	0.00	NCI/M2	LASL77
2134	C060	1977	INSITU	6.58	.55	7913.00	NCI/M2	LASL77
1997	C060	1977	INSITU	6.46	1.16	0.00	NCI/M2	LASL77
2122	C060	1977	INSITU	13.69	6.87	0.00	NCI/M2	LASL77
2076	C060	1977	INSITU	11.09	4.52	0.00	NCI/M2	LASL77
2049	C060	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2100	C060	1977	INSITU	14.50	12.20	0.00	NCI/M2	LASL77
2012	C060	1977	INSITU	6.79	1.77	0.00	NCI/M2	LASL77
2031	C060	1977	INSITU	10.41	4.28	0.00	NCI/M2	LASL77
2038	C060	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
1996	C060	1977	INSITU	6.45	.75	0.00	NCI/M2	LASL77
2042	C060	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77
2032	C060	1977	INSITU	3.17	3.48	1.09	NCI/M2	LASL77
2074	C060	1977	INSITU	9.85	4.35	0.00	NCI/M2	LASL77
2014	C060	1977	INSITU	7.37	2.22	503.50	NCI/M2	LASL77
2087	C060	1977	INSITU	12.92	7.66	0.00	NCI/M2	LASL77
2138	C060	1977	INSITU	5.81	2.17	76.93	NCI/M2	LASL77
2082	C060	1977	INSITU	11.62	7.18	0.00	NCI/M2	LASL77
2130	C060	1977	INSITU	6.03	.60	0.00	NCI/M2	LASL77
2092	C060	1977	INSITU	13.52	9.21	0.00	NCI/M2	LASL77
2030	C060	1977	INSITU	10.39	4.30	0.00	NCI/M2	LASL77
2085	C060	1977	INSITU	12.60	6.58	2.09	NCI/M2	LASL77
2040	C060	1977	INSITU	9.60	4.32	1.97	NCI/M2	LASL77
2146	C060	1977	INSITU	9.82	4.27	1.31	NCI/M2	LASL77
2068	C060	1977	INSITU	9.30	5.02	0.00	NCI/M2	LASL77
2052	C060	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2020	C060	1977	INSITU	3.17	3.48	0.00	NCI/M2	LASL77
2116	C060	1977	INSITU	13.74	6.12	0.00	NCI/M2	LASL77
2075	C060	1977	INSITU	10.85	4.60	0.00	NCI/M2	LASL77
2033	C060	1977	INSITU	3.14	3.57	30.76	NCI/M2	LASL77
2022	C060	1977	INSITU	9.60	4.32	1.93	NCI/M2	LASL77
2153	C060	1977	INSITU	3.94	4.88	0.00	NCI/M2	LASL77
2131	C060	1977	INSITU	6.62	1.87	0.00	NCI/M2	LASL77
2023	C060	1977	INSITU	9.54	3.98	3.71	NCI/M2	LASL77
2053	C060	1977	INSITU	10.69	5.56	0.00	NCI/M2	LASL77
1998	C060	1977	INSITU	6.63	.55	44.76	NCI/M2	LASL77
2073	C060	1977	INSITU	9.86	4.42	0.00	NCI/M2	LASL77
2043	C060	1977	INSITU	3.91	3.49	50.30	NCI/M2	LASL77
2101	C060	1977	INSITU	16.52	14.74	1.78	NCI/M2	LASL77
2061	C060	1977	INSITU	9.91	5.07	0.00	NCI/M2	LASL77
2006	C060	1977	INSITU	7.07	2.04	1.97	NCI/M2	LASL77
2008	C060	1977	INSITU	7.40	2.10	2.01	NCI/M2	LASL77
2009	C060	1977	INSITU	6.59	1.65	3.63	NCI/M2	LASL77
2015	C060	1977	INSITU	7.37	2.31	0.00	NCI/M2	LASL77
2099	C060	1977	INSITU	11.12	10.93	0.00	NCI/M2	LASL77
2060	C060	1977	INSITU	9.91	5.07	0.00	NCI/M2	LASL77
2154	C060	1977	INSITU	3.95	4.57	1.66	NCI/M2	LASL77
2090	C060	1977	INSITU	13.85	7.69	0.00	NCI/M2	LASL77
2058	C060	1977	INSITU	10.00	5.31	0.00	NCI/M2	LASL77
2037	C060	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77
2057	C060	1977	INSITU	10.35	5.34	0.00	NCI/M2	LASL77
2072	C060	1977	INSITU	9.86	4.42	0.00	NCI/M2	LASL77
2048	C060	1977	INSITU	11.09	5.87	0.00	NCI/M2	LASL77
2097	C060	1977	INSITU	15.45	9.75	16.28	NCI/M2	LASL77
2010	C060	1977	INSITU	6.79	1.71	0.00	NCI/M2	LASL77
2055	C060	1977	INSITU	11.35	5.86	0.00	NCI/M2	LASL77
2088	C060	1977	INSITU	13.22	7.66	0.00	NCI/M2	LASL77
2142	C060	1977	INSITU	6.27	.00	0.00	NCI/M2	LASL77
2064	C060	1977	INSITU	10.54	7.19	0.00	NCI/M2	LASL77
2121	C060	1977	INSITU	13.68	6.87	0.00	NCI/M2	LASL77
2062	C060	1977	INSITU	9.83	5.10	0.00	NCI/M2	LASL77
2013	C060	1977	INSITU	7.43	2.11	0.00	NCI/M2	LASL77
2024	C060	1977	INSITU	8.95	3.88	1.59	NCI/M2	LASL77
2065	C060	1977	INSITU	10.39	5.01	0.00	NCI/M2	LASL77
2081	C060	1977	INSITU	11.31	7.21	0.00	NCI/M2	LASL77
2066	C060	1977	INSITU	10.60	4.42	0.00	NCI/M2	LASL77
2027	C060	1977	INSITU	10.28	4.20	2.51	NCI/M2	LASL77
2093	C060	1977	INSITU	14.60	8.57	0.00	NCI/M2	LASL77
2128	C060	1977	INSITU	13.77	5.47	0.00	NCI/M2	LASL77
2114	C060	1977	INSITU	10.46	7.18	0.00	NCI/M2	LASL77
2096	C060	1977	INSITU	14.49	9.24	0.00	NCI/M2	LASL77
2067	C060	1977	INSITU	9.31	4.96	.83	NCI/M2	LASL77

2126	C060	1977	INSITU	12.45	4.27	0.00	NCI/M2	LASL77
2132	C060	1977	INSITU	6.70	2.16	0.00	NCI/M2	LASL77
2079	C060	1977	INSITU	10.53	7.20	0.00	NCI/M2	LASL77
2127	C060	1977	INSITU	13.40	5.21	1.87	NCI/M2	LASL77
2123	C060	1977	INSITU	13.68	6.79	0.00	NCI/M2	LASL77
2118	C060	1977	INSITU	14.55	6.45	0.00	NCI/M2	LASL77
2125	C060	1977	INSITU	14.68	4.45	0.00	NCI/M2	LASL77
2129	C060	1977	INSITU	6.27	0.00	0.00	NCI/M2	LASL77
2049	C060	1977	SG	11.11	5.55	0.00	PCI/GM	LLL GELI
2016	C060	1977	SK	7.24	2.33	0.00	PCI/GM	LLL GELI
1991	C060	1977	SK	6.63	.55	.09	PCI/GM	LLL GELI
2045	C060	1977	SK	10.52	5.51	0.00	PCI/GM	LLL GELI
2007	C060	1977	SK	7.10	2.07	.27	PCI/GM	LLL GELI
1987	C060	1977	SK	6.63	.55	.25	PCI/GM	LLL GELI
2028	C060	1977	TH	10.37	4.33	0.00	PCI/GM	LLL GELI
2052	C060	1977	UK	11.11	5.55	.22	PCI/GM	LLL GELI
1988	CS137	1977	GR	6.64	.55	.42	PCI/GM	LLL GELI
2018	CS137	1977	GR	6.66	1.76	.37	PCI/GM	LLL GELI
2055	CS137	1977	GR	11.35	5.86	.41	PCI/GM	LLL GELI
1990	CS137	1977	GR	6.64	.55	.42	PCI/GM	LLL GELI
2154	CS137	1977	INSITU	3.95	4.57	56.20	NCI/M2	LASL77
2071	CS137	1977	INSITU	9.83	4.48	388.70	NCI/M2	LASL77
2079	CS137	1977	INSITU	10.53	7.20	51.80	NCI/M2	LASL77
2015	CS137	1977	INSITU	7.37	2.31	96.20	NCI/M2	LASL77
2033	CS137	1977	INSITU	3.14	3.57	65.90	NCI/M2	LASL77
2077	CS137	1977	INSITU	10.31	4.41	61.69	NCI/M2	LASL77
2146	CS137	1977	INSITU	9.82	4.27	538.50	NCI/M2	LASL77
2130	CS137	1977	INSITU	6.03	.60	2.13	NCI/M2	LASL77
2012	CS137	1977	INSITU	6.79	1.77	236.60	NCI/M2	LASL77
2019	CS137	1977	INSITU	6.69	2.24	26.40	NCI/M2	LASL77
2028	CS137	1977	INSITU	10.37	4.33	947.00	NCI/M2	LASL77
2067	CS137	1977	INSITU	9.31	4.96	127.60	NCI/M2	LASL77
2132	CS137	1977	INSITU	6.70	2.16	231.80	NCI/M2	LASL77
2092	CS137	1977	INSITU	13.52	9.21	55.70	NCI/M2	LASL77
2065	CS137	1977	INSITU	10.39	5.01	271.90	NCI/M2	LASL77
2043	CS137	1977	INSITU	3.91	3.49	39.10	NCI/M2	LASL77
2097	CS137	1977	INSITU	15.45	9.75	732.30	NCI/M2	LASL77
2072	CS137	1977	INSITU	9.86	4.42	756.60	NCI/M2	LASL77
2052	CS137	1977	INSITU	11.11	5.55	123.10	NCI/M2	LASL77
2061	CS137	1977	INSITU	9.91	5.07	125.10	NCI/M2	LASL77
2148	CS137	1977	INSITU	2.98	3.62	49.90	NCI/M2	LASL77
2087	CS137	1977	INSITU	12.92	7.66	188.50	NCI/M2	LASL77
2131	CS137	1977	INSITU	6.62	1.87	42.45	NCI/M2	LASL77
2083	CS137	1977	INSITU	12.14	7.19	219.30	NCI/M2	LASL77
2101	CS137	1977	INSITU	16.52	14.74	78.68	NCI/M2	LASL77
2064	CS137	1977	INSITU	10.54	7.19	48.20	NCI/M2	LASL77
2090	CS137	1977	INSITU	13.85	7.69	127.80	NCI/M2	LASL77
2022	CS137	1977	INSITU	9.60	4.32	481.80	NCI/M2	LASL77
2155	CS137	1977	INSITU	3.91	3.49	49.30	NCI/M2	LASL77
2048	CS137	1977	INSITU	11.09	5.87	101.20	NCI/M2	LASL77
2066	CS137	1977	INSITU	10.60	4.42	338.50	NCI/M2	LASL77
2122	CS137	1977	INSITU	13.69	6.87	152.60	NCI/M2	LASL77
2030	CS137	1977	INSITU	10.39	4.30	590.00	NCI/M2	LASL77
2050	CS137	1977	INSITU	11.11	5.55	125.20	NCI/M2	LASL77
2125	CS137	1977	INSITU	14.68	4.45	90.60	NCI/M2	LASL77
2082	CS137	1977	INSITU	11.62	7.18	142.60	NCI/M2	LASL77
2153	CS137	1977	INSITU	3.94	4.88	57.30	NCI/M2	LASL77
2076	CS137	1977	INSITU	11.09	4.52	158.80	NCI/M2	LASL77
2038	CS137	1977	INSITU	9.60	4.32	338.80	NCI/M2	LASL77
2037	CS137	1977	INSITU	9.82	4.27	545.10	NCI/M2	LASL77
2073	CS137	1977	INSITU	9.86	4.42	547.90	NCI/M2	LASL77
2016	CS137	1977	INSITU	7.24	2.33	84.60	NCI/M2	LASL77
2135	CS137	1977	INSITU	6.58	.55	16000.00	NCI/M2	LASL77
2093	CS137	1977	INSITU	14.60	8.57	145.10	NCI/M2	LASL77
2053	CS137	1977	INSITU	10.69	5.56	189.00	NCI/M2	LASL77
2123	CS137	1977	INSITU	13.68	6.79	111.50	NCI/M2	LASL77
2147	CS137	1977	INSITU	7.77	3.07	69.20	NCI/M2	LASL77
1998	CS137	1977	INSITU	6.63	.55	328.60	NCI/M2	LASL77
2088	CS137	1977	INSITU	13.22	7.66	176.30	NCI/M2	LASL77
2096	CS137	1977	INSITU	14.49	9.24	97.80	NCI/M2	LASL77
2081	CS137	1977	INSITU	11.31	7.21	135.50	NCI/M2	LASL77
2040	CS137	1977	INSITU	9.60	4.32	308.00	NCI/M2	LASL77
2143	CS137	1977	INSITU	4.81	3.00	33.94	NCI/M2	LASL77
2018	CS137	1977	INSITU	6.66	1.76	90.90	NCI/M2	LASL77
2116	CS137	1977	INSITU	13.74	6.12	84.40	NCI/M2	LASL77
2047	CS137	1977	INSITU	11.08	5.74	171.70	NCI/M2	LASL77
2025	CS137	1977	INSITU	10.12	4.27	601.70	NCI/M2	LASL77
2058	CS137	1977	INSITU	10.00	5.31	323.40	NCI/M2	LASL77
2119	CS137	1977	INSITU	14.34	7.21	79.51	NCI/M2	LASL77
2068	CS137	1977	INSITU	9.30	5.02	263.30	NCI/M2	LASL77

2094	CS137	1977	INSITU		14.49	9.25	103.40	NCI/M2	LASL77
1997	CS137	1977	INSITU		6.46	1.16	223.20	NCI/M2	LASL77
2127	CS137	1977	INSITU		13.40	5.21	10.34	NCI/M2	LASL77
2039	CS137	1977	INSITU		9.60	4.32	428.30	NCI/M2	LASL77
2084	CS137	1977	INSITU		12.58	7.17	141.20	NCI/M2	LASL77
2034	CS137	1977	INSITU		3.16	3.70	219.70	NCI/M2	LASL77
2075	CS137	1977	INSITU		10.85	4.60	40.60	NCI/M2	LASL77
2059	CS137	1977	INSITU		9.74	5.42	211.30	NCI/M2	LASL77
2138	CS137	1977	INSITU		5.81	2.17	543.80	NCI/M2	LASL77
2074	CS137	1977	INSITU		9.85	4.35	260.90	NCI/M2	LASL77
2120	CS137	1977	INSITU		14.30	7.16	127.90	NCI/M2	LASL77
2060	CS137	1977	INSITU		9.91	5.07	317.90	NCI/M2	LASL77
2144	CS137	1977	INSITU		10.46	7.19	40.70	NCI/M2	LASL77
2042	CS137	1977	INSITU		9.82	4.27	512.10	NCI/M2	LASL77
2141	CS137	1977	INSITU		6.58	.55	488.30	NCI/M2	LASL77
2032	CS137	1977	INSITU		3.17	3.48	69.90	NCI/M2	LASL77
2013	CS137	1977	INSITU		7.43	2.11	43.60	NCI/M2	LASL77
2129	CS137	1977	INSITU		6.27	0.00	31.83	NCI/M2	LASL77
2031	CS137	1977	INSITU		10.41	4.28	261.00	NCI/M2	LASL77
2041	CS137	1977	INSITU		9.61	4.32	428.00	NCI/M2	LASL77
2095	CS137	1977	INSITU		14.49	9.25	68.60	NCI/M2	LASL77
2115	CS137	1977	INSITU		13.57	6.49	83.70	NCI/M2	LASL77
2017	CS137	1977	INSITU		7.25	2.33	34.60	NCI/M2	LASL77
2024	CS137	1977	INSITU		8.95	3.88	135.30	NCI/M2	LASL77
2085	CS137	1977	INSITU		12.60	6.58	764.90	NCI/M2	LASL77
2139	CS137	1977	INSITU		6.58	.55	4179.00	NCI/M2	LASL77
2055	CS137	1977	INSITU		11.35	5.86	29.50	NCI/M2	LASL77
2099	CS137	1977	INSITU		11.12	10.93	72.30	NCI/M2	LASL77
2010	CS137	1977	INSITU		6.79	1.71	91.70	NCI/M2	LASL77
2011	CS137	1977	INSITU		6.32	.00	36.90	NCI/M2	LASL77
2121	CS137	1977	INSITU		13.68	6.87	124.40	NCI/M2	LASL77
2128	CS137	1977	INSITU		13.77	5.47	25.37	NCI/M2	LASL77
2057	CS137	1977	INSITU		10.35	5.34	158.70	NCI/M2	LASL77
2020	CS137	1977	INSITU		3.17	3.48	0.00	NCI/M2	LASL77
2027	CS137	1977	INSITU		10.28	4.20	314.00	NCI/M2	LASL77
2008	CS137	1977	INSITU		7.40	2.10	25.36	NCI/M2	LASL77
2023	CS137	1977	INSITU		9.54	3.98	282.60	NCI/M2	LASL77
2136	CS137	1977	INSITU		6.58	.55	23000.00	NCI/M2	LASL77
2006	CS137	1977	INSITU		7.07	2.04	182.20	NCI/M2	LASL77
2142	CS137	1977	INSITU		6.27	.00	30.00	NCI/M2	LASL77
2086	CS137	1977	INSITU		10.53	7.19	48.40	NCI/M2	LASL77
2007	CS137	1977	INSITU		7.10	2.07	183.80	NCI/M2	LASL77
2009	CS137	1977	INSITU		6.59	1.65	244.60	NCI/M2	LASL77
2080	CS137	1977	INSITU		10.91	7.22	81.50	NCI/M2	LASL77
2140	CS137	1977	INSITU		6.58	.55	730.40	NCI/M2	LASL77
2126	CS137	1977	INSITU		12.45	4.27	58.90	NCI/M2	LASL77
2026	CS137	1977	INSITU		10.05	4.07	540.00	NCI/M2	LASL77
2014	CS137	1977	INSITU		7.37	2.22	858.20	NCI/M2	LASL77
1996	CS137	1977	INSITU		6.45	.75	227.60	NCI/M2	LASL77
2029	CS137	1977	INSITU		10.35	4.28	410.70	NCI/M2	LASL77
2114	CS137	1977	INSITU		10.46	7.18	50.55	NCI/M2	LASL77
2134	CS137	1977	INSITU		6.58	.55	4230.00	NCI/M2	LASL77
2118	CS137	1977	INSITU		14.55	6.45	100.00	NCI/M2	LASL77
2049	CS137	1977	INSITU		11.11	5.55	139.60	NCI/M2	LASL77
2062	CS137	1977	INSITU		9.83	5.10	241.00	NCI/M2	LASL77
2100	CS137	1977	INSITU		14.50	12.20	80.90	NCI/M2	LASL77
2049	CS137	1977	SG		11.11	5.55	0.00	PCI/GM	LLL GELI
1991	CS137	1977	SK		6.63	.55	.06	PCI/GM	LLL GELI
2016	CS137	1977	SK		7.24	2.33	.24	PCI/GM	LLL GELI
1987	CS137	1977	SK		6.63	.55	0.00	PCI/GM	LLL GELI
2045	CS137	1977	SK		10.52	5.51	.38	PCI/GM	LLL GELI
2007	CS137	1977	SK		7.10	2.07	.34	PCI/GM	LLL GELI
2028	CS137	1977	SOIL	12.5	10.37	4.33	0.00	PCI/GM	LLL GELI
2074	CS137	1977	SOIL	2.5	9.85	4.35	1.29	PCI/GM	LLL GELI
2059	CS137	1977	SOIL	12.5	9.74	5.42	0.00	PCI/GM	LLL GELI
2014	CS137	1977	SOIL	12.5	7.37	2.22	.96	PCI/GM	LLL GELI
2048	CS137	1977	SOIL	7.5	11.09	5.87	.13	PCI/GM	LLL GELI
1991	CS137	1977	SOIL	7.5	6.63	.55	9.40	PCI/GM	LLL GELI
2120	CS137	1977	SOIL	2.5	14.30	7.16	1.74	PCI/GM	LLL GELI
2120	CS137	1977	SOIL	12.5	14.30	7.16	0.00	PCI/GM	LLL GELI
2014	CS137	1977	SOIL	2.5	7.37	2.22	.99	PCI/GM	LLL GELI
2087	CS137	1977	SOIL	2.5	12.92	7.66	2.99	PCI/GM	LLL GELI
2012	CS137	1977	SOIL	7.5	6.79	1.77	0.00	PCI/GM	LLL GELI
2072	CS137	1977	SOIL	2.5	9.86	4.42	7.12	PCI/GM	LLL GELI
2050	CS137	1977	SOIL	2.5	11.11	5.55	.78	PCI/GM	LLL GELI
2066	CS137	1977	SOIL	2.5	10.60	4.42	1.51	PCI/GM	LLL GELI
2007	CS137	1977	SOIL	7.5	7.10	2.07	.03	PCI/GM	LLL GELI
2015	CS137	1977	SOIL	2.5	7.37	2.31	1.15	PCI/GM	LLL GELI
2016	CS137	1977	SOIL	7.5	7.24	2.33	.26	PCI/GM	LLL GELI
2080	CS137	1977	SOIL	2.5	10.91	7.22	.32	PCI/GM	LLL GELI

2045	CS137	1977	SOIL	12.5	10.52	5.51	.08	PCI/GM	LLL GELI
2116	CS137	1977	SOIL	12.5	13.74	6.12	0.00	PCI/GM	LLL GELI
2058	CS137	1977	SOIL	12.5	10.00	5.31	.08	PCI/GM	LLL GELI
2012	CS137	1977	SOIL	2.5	6.79	1.77	.22	PCI/GM	LLL GELI
2071	CS137	1977	SOIL	2.5	9.83	4.48	3.09	PCI/GM	LLL GELI
2018	CS137	1977	SOIL	7.5	6.66	1.76	.36	PCI/GM	LLL GELI
2046	CS137	1977	SOIL	2.5	11.08	5.73	.57	PCI/GM	LLL GELI
2049	CS137	1977	SOIL	2.5	11.11	5.55	.83	PCI/GM	LLL GELI
2055	CS137	1977	SOIL	2.5	11.35	5.86	0.00	PCI/GM	LLL GELI
2045	CS137	1977	SOIL	7.5	10.52	5.51	.22	PCI/GM	LLL GELI
2018	CS137	1977	SOIL	2.5	6.66	1.76	.48	PCI/GM	LLL GELI
2005	CS137	1977	SOIL	7.5	7.02	2.00	.46	PCI/GM	LLL GELI
2071	CS137	1977	SOIL	12.5	9.83	4.48	.08	PCI/GM	LLL GELI
2028	CS137	1977	SOIL	2.5	10.37	4.33	5.87	PCI/GM	LLL GELI
2118	CS137	1977	SOIL	2.5	14.55	6.45	2.05	PCI/GM	LLL GELI
2115	CS137	1977	SOIL	7.5	13.57	6.49	.09	PCI/GM	LLL GELI
2046	CS137	1977	SOIL	12.5	11.08	5.73	0.00	PCI/GM	LLL GELI
2007	CS137	1977	SOIL	12.5	7.10	2.07	0.00	PCI/GM	LLL GELI
1990	CS137	1977	SOIL	7.5	6.64	.55	21.41	PCI/GM	LLL GELI
2087	CS137	1977	SOIL	7.5	12.92	7.66	0.00	PCI/GM	LLL GELI
2016	CS137	1977	SOIL	12.5	7.24	2.33	.11	PCI/GM	LLL GELI
2009	CS137	1977	SOIL	7.5	6.59	1.65	1.81	PCI/GM	LLL GELI
2029	CS137	1977	SOIL	2.5	10.35	4.28	.32	PCI/GM	LLL GELI
2084	CS137	1977	SOIL	2.5	12.58	7.17	1.78	PCI/GM	LLL GELI
2059	CS137	1977	SOIL	2.5	9.74	5.42	1.03	PCI/GM	LLL GELI
2023	CS137	1977	SOIL	2.5	9.54	3.98	6.90	PCI/GM	LLL GELI
2082	CS137	1977	SOIL	2.5	11.62	7.18	2.10	PCI/GM	LLL GELI
2019	CS137	1977	SOIL	2.5	6.69	2.24	.25	PCI/GM	LLL GELI
2018	CS137	1977	SOIL	12.5	6.66	1.76	0.00	PCI/GM	LLL GELI
2115	CS137	1977	SOIL	12.5	13.57	6.49	0.00	PCI/GM	LLL GELI
2027	CS137	1977	SOIL	12.5	10.28	4.20	.21	PCI/GM	LLL GELI
2118	CS137	1977	SOIL	7.5	14.55	6.45	.10	PCI/GM	LLL GELI
2030	CS137	1977	SOIL	2.5	10.39	4.30	6.04	PCI/GM	LLL GELI
2058	CS137	1977	SOIL	2.5	10.00	5.31	5.09	PCI/GM	LLL GELI
1988	CS137	1977	SOIL	2.5	6.64	.55	27.19	PCI/GM	LLL GELI
2007	CS137	1977	SOIL	2.5	7.10	2.07	.49	PCI/GM	LLL GELI
2080	CS137	1977	SOIL	12.5	10.91	7.22	.11	PCI/GM	LLL GELI
1991	CS137	1977	SOIL	2.5	6.63	.55	6.07	PCI/GM	LLL GELI
2083	CS137	1977	SOIL	2.5	12.14	7.19	1.98	PCI/GM	LLL GELI
2052	CS137	1977	SOIL	2.5	11.11	5.55	.24	PCI/GM	LLL GELI
2116	CS137	1977	SOIL	2.5	13.74	6.12	1.97	PCI/GM	LLL GELI
2016	CS137	1977	SOIL	2.5	7.24	2.33	.82	PCI/GM	LLL GELI
1988	CS137	1977	SOIL	12.5	6.64	.55	.35	PCI/GM	LLL GELI
2048	CS137	1977	SOIL	12.5	11.09	5.87	0.00	PCI/GM	LLL GELI
2088	CS137	1977	SOIL	2.5	13.22	7.66	2.25	PCI/GM	LLL GELI
1990	CS137	1977	SOIL	12.5	6.64	.55	6.91	PCI/GM	LLL GELI
2081	CS137	1977	SOIL	2.5	11.31	7.21	1.29	PCI/GM	LLL GELI
1988	CS137	1977	SOIL	7.5	6.64	.55	24.95	PCI/GM	LLL GELI
1989	CS137	1977	SOIL	7.5	6.63	.55	.17	PCI/GM	LLL GELI
2026	CS137	1977	SOIL	2.5	10.05	4.07	5.37	PCI/GM	LLL GELI
2053	CS137	1977	SOIL	2.5	10.69	5.56	.71	PCI/GM	LLL GELI
2115	CS137	1977	SOIL	2.5	13.57	6.49	2.94	PCI/GM	LLL GELI
2019	CS137	1977	SOIL	7.5	6.69	2.24	.18	PCI/GM	LLL GELI
2057	CS137	1977	SOIL	12.5	10.35	5.34	0.00	PCI/GM	LLL GELI
2028	CS137	1977	SOIL	7.5	10.37	4.33	.18	PCI/GM	LLL GELI
2005	CS137	1977	SOIL	2.5	7.02	2.00	.76	PCI/GM	LLL GELI
2019	CS137	1977	SOIL	12.5	6.69	2.24	0.00	PCI/GM	LLL GELI
1989	CS137	1977	SOIL	2.5	6.63	.55	1.75	PCI/GM	LLL GELI
2012	CS137	1977	SOIL	12.5	6.79	1.77	0.00	PCI/GM	LLL GELI
1989	CS137	1977	SOIL	12.5	6.63	.55	0.00	PCI/GM	LLL GELI
2049	CS137	1977	SOIL	12.5	11.11	5.55	0.00	PCI/GM	LLL GELI
1992	CS137	1977	SOIL	7.5	6.66	.70	0.00	PCI/GM	LLL GELI
2073	CS137	1977	SOIL	2.5	9.86	4.42	10.40	PCI/GM	LLL GELI
2050	CS137	1977	SOIL	22.5	11.11	5.55	.05	PCI/GM	LLL GELI
2097	CS137	1977	SOIL	2.5	15.45	9.75	1.56	PCI/GM	LLL GELI
2027	CS137	1977	SOIL	2.5	10.28	4.20	3.17	PCI/GM	LLL GELI
2045	CS137	1977	SOIL	2.5	10.52	5.51	1.16	PCI/GM	LLL GELI
2120	CS137	1977	SOIL	7.5	14.30	7.16	1.00	PCI/GM	LLL GELI
2116	CS137	1977	SOIL	7.5	13.74	6.12	0.00	PCI/GM	LLL GELI
2057	CS137	1977	SOIL	2.5	10.35	5.34	1.69	PCI/GM	LLL GELI
2074	CS137	1977	SOIL	12.5	9.85	4.35	0.00	PCI/GM	LLL GELI
1990	CS137	1977	SOIL	2.5	6.64	.55	13.62	PCI/GM	LLL GELI
2095	CS137	1977	SOIL	2.5	14.49	9.25	.95	PCI/GM	LLL GELI
2027	CS137	1977	SOIL	7.5	10.28	4.20	.12	PCI/GM	LLL GELI
2026	CS137	1977	SOIL	12.5	10.05	4.07	0.00	PCI/GM	LLL GELI
2118	CS137	1977	SOIL	12.5	14.55	6.45	0.00	PCI/GM	LLL GELI
1991	CS137	1977	SOIL	12.5	6.63	.55	0.00	PCI/GM	LLL GELI
2052	CS137	1977	SOIL	12.5	11.11	5.55	0.00	PCI/GM	LLL GELI
2031	CS137	1977	SOIL	2.5	10.41	4.28	5.04	PCI/GM	LLL GELI
2048	CS137	1977	SOIL	2.5	11.09	5.87	1.07	PCI/GM	LLL GELI

2050	CS137	1977	SOIL	12.5	11.11	5.55	0.00	PCI/GM	LLL	GELI
2061	CS137	1977	SOIL	2.5	9.91	5.07	2.84	PCI/GM	LLL	GELI
2053	CS137	1977	SOIL	12.5	10.69	5.56	.06	PCI/GM	LLL	GELI
2028	CS137	1977	TH		10.37	4.33	.35	PCI/GM	LLL	GELI
2052	CS137	1977	UK		11.11	5.55	.20	PCI/GM	LLL	GELI
2018	EU152	1977	GR		6.66	1.76	0.00	PCI/GM	LLL	GELI
1990	EU152	1977	GR		6.64	.55	1.02	PCI/GM	LLL	GELI
1988	EU152	1977	GR		6.64	.55	2.21	PCI/GM	LLL	GELI
2055	EU152	1977	GR		11.35	5.86	0.00	PCI/GM	LLL	GELI
2100	EU152	1977	INSITU		14.50	12.20	0.00	NCI/M2	LASL77	
2148	EU152	1977	INSITU		2.98	3.62	0.00	NCI/M2	LASL77	
2144	EU152	1977	INSITU		10.46	7.19	0.00	NCI/M2	LASL77	
2094	EU152	1977	INSITU		14.49	9.25	0.00	NCI/M2	LASL77	
2040	EU152	1977	INSITU		9.60	4.32	0.00	NCI/M2	LASL77	
2018	EU152	1977	INSITU		6.66	1.76	0.00	NCI/M2	LASL77	
2092	EU152	1977	INSITU		13.52	9.21	0.00	NCI/M2	LASL77	
2031	EU152	1977	INSITU		10.41	4.28	0.00	NCI/M2	LASL77	
2052	EU152	1977	INSITU		11.11	5.55	0.00	NCI/M2	LASL77	
2060	EU152	1977	INSITU		9.91	5.07	0.00	NCI/M2	LASL77	
2128	EU152	1977	INSITU		13.77	5.47	0.00	NCI/M2	LASL77	
2057	EU152	1977	INSITU		10.35	5.34	0.00	NCI/M2	LASL77	
2043	EU152	1977	INSITU		3.91	3.49	0.00	NCI/M2	LASL77	
2006	EU152	1977	INSITU		7.07	2.04	0.00	NCI/M2	LASL77	
2039	EU152	1977	INSITU		9.60	4.32	0.00	NCI/M2	LASL77	
2136	EU152	1977	INSITU		6.58	.55	150000.00	NCI/M2	LASL77	
2120	EU152	1977	INSITU		14.30	7.16	0.00	NCI/M2	LASL77	
2065	EU152	1977	INSITU		10.39	5.01	0.00	NCI/M2	LASL77	
2058	EU152	1977	INSITU		10.00	5.31	0.00	NCI/M2	LASL77	
2097	EU152	1977	INSITU		15.45	9.75	0.00	NCI/M2	LASL77	
2066	EU152	1977	INSITU		10.60	4.42	0.00	NCI/M2	LASL77	
1996	EU152	1977	INSITU		6.45	.75	0.00	NCI/M2	LASL77	
1997	EU152	1977	INSITU		6.46	1.16	0.00	NCI/M2	LASL77	
2037	EU152	1977	INSITU		9.82	4.27	0.00	NCI/M2	LASL77	
2088	EU152	1977	INSITU		13.22	7.66	0.00	NCI/M2	LASL77	
2027	EU152	1977	INSITU		10.28	4.20	0.00	NCI/M2	LASL77	
2064	EU152	1977	INSITU		10.54	7.19	0.00	NCI/M2	LASL77	
2022	EU152	1977	INSITU		9.60	4.32	0.00	NCI/M2	LASL77	
2059	EU152	1977	INSITU		9.74	5.42	0.00	NCI/M2	LASL77	
2017	EU152	1977	INSITU		7.25	2.33	0.00	NCI/M2	LASL77	
2014	EU152	1977	INSITU		7.37	2.22	0.00	NCI/M2	LASL77	
2011	EU152	1977	INSITU		6.32	.00	0.00	NCI/M2	LASL77	
2122	EU152	1977	INSITU		13.69	6.87	0.00	NCI/M2	LASL77	
2141	EU152	1977	INSITU		6.58	.55	1221.00	NCI/M2	LASL77	
2099	EU152	1977	INSITU		11.12	10.93	0.00	NCI/M2	LASL77	
2008	EU152	1977	INSITU		7.40	2.10	0.00	NCI/M2	LASL77	
2042	EU152	1977	INSITU		9.82	4.27	0.00	NCI/M2	LASL77	
2081	EU152	1977	INSITU		11.31	7.21	0.00	NCI/M2	LASL77	
2020	EU152	1977	INSITU		3.17	3.48	0.00	NCI/M2	LASL77	
2016	EU152	1977	INSITU		7.24	2.33	0.00	NCI/M2	LASL77	
2095	EU152	1977	INSITU		14.49	9.25	0.00	NCI/M2	LASL77	
2067	EU152	1977	INSITU		9.31	4.96	0.00	NCI/M2	LASL77	
2147	EU152	1977	INSITU		7.77	3.07	0.00	NCI/M2	LASL77	
2087	EU152	1977	INSITU		12.92	7.66	0.00	NCI/M2	LASL77	
2119	EU152	1977	INSITU		14.34	7.21	0.00	NCI/M2	LASL77	
2114	EU152	1977	INSITU		10.46	7.18	0.00	NCI/M2	LASL77	
2041	EU152	1977	INSITU		9.61	4.32	0.00	NCI/M2	LASL77	
2012	EU152	1977	INSITU		6.79	1.77	0.00	NCI/M2	LASL77	
2096	EU152	1977	INSITU		14.49	9.24	0.00	NCI/M2	LASL77	
2015	EU152	1977	INSITU		7.37	2.31	0.00	NCI/M2	LASL77	
2142	EU152	1977	INSITU		6.27	.00	0.00	NCI/M2	LASL77	
2079	EU152	1977	INSITU		10.53	7.20	0.00	NCI/M2	LASL77	
2013	EU152	1977	INSITU		7.43	2.11	0.00	NCI/M2	LASL77	
1998	EU152	1977	INSITU		6.63	.55	621.60	NCI/M2	LASL77	
2076	EU152	1977	INSITU		11.09	4.52	0.00	NCI/M2	LASL77	
2010	EU152	1977	INSITU		6.79	1.71	0.00	NCI/M2	LASL77	
2062	EU152	1977	INSITU		9.83	5.10	0.00	NCI/M2	LASL77	
2127	EU152	1977	INSITU		13.40	5.21	0.00	NCI/M2	LASL77	
2135	EU152	1977	INSITU		6.58	.55	340000.00	NCI/M2	LASL77	
2019	EU152	1977	INSITU		6.69	2.24	0.00	NCI/M2	LASL77	
2074	EU152	1977	INSITU		9.85	4.35	0.00	NCI/M2	LASL77	
2009	EU152	1977	INSITU		6.59	1.65	0.00	NCI/M2	LASL77	
2125	EU152	1977	INSITU		14.68	4.45	0.00	NCI/M2	LASL77	
2146	EU152	1977	INSITU		9.82	4.27	0.00	NCI/M2	LASL77	
2139	EU152	1977	INSITU		6.58	.55	11000.00	NCI/M2	LASL77	
2024	EU152	1977	INSITU		8.95	3.88	0.00	NCI/M2	LASL77	
2032	EU152	1977	INSITU		3.17	3.48	0.00	NCI/M2	LASL77	
2129	EU152	1977	INSITU		6.27	0.00	0.00	NCI/M2	LASL77	
2049	EU152	1977	INSITU		11.11	5.55	0.00	NCI/M2	LASL77	
2085	EU152	1977	INSITU		12.60	6.58	0.00	NCI/M2	LASL77	
2134	EU152	1977	INSITU		6.58	.55	140000.00	NCI/M2	LASL77	

2126	EU152	1977	INSITU	12.45	4.27	0.00	NCI/M2	LASL77	
2028	EU152	1977	INSITU	10.37	4.33	0.00	NCI/M2	LASL77	
2086	EU152	1977	INSITU	10.53	7.19	0.00	NCI/M2	LASL77	
2121	EU152	1977	INSITU	13.68	6.87	0.00	NCI/M2	LASL77	
2118	EU152	1977	INSITU	14.55	6.45	0.00	NCI/M2	LASL77	
2071	EU152	1977	INSITU	9.83	4.48	0.00	NCI/M2	LASL77	
2082	EU152	1977	INSITU	11.62	7.18	0.00	NCI/M2	LASL77	
2140	EU152	1977	INSITU	6.58	.55	842.60	NCI/M2	LASL77	
2038	EU152	1977	INSITU	9.50	4.32	0.00	NCI/M2	LASL77	
2007	EU152	1977	INSITU	7.10	2.07	0.00	NCI/M2	LASL77	
2138	EU152	1977	INSITU	5.81	2.17	1696.00	NCI/M2	LASL77	
2143	EU152	1977	INSITU	4.81	3.00	0.00	NCI/M2	LASL77	
2132	EU152	1977	INSITU	6.70	2.16	0.00	NCI/M2	LASL77	
2034	EU152	1977	INSITU	3.16	3.70	0.00	NCI/M2	LASL77	
2155	EU152	1977	INSITU	3.91	3.49	0.00	NCI/M2	LASL77	
2053	EU152	1977	INSITU	10.69	5.56	0.00	NCI/M2	LASL77	
2026	EU152	1977	INSITU	10.05	4.07	0.00	NCI/M2	LASL77	
2154	EU152	1977	INSITU	3.95	4.57	0.00	NCI/M2	LASL77	
2080	EU152	1977	INSITU	10.91	7.22	0.00	NCI/M2	LASL77	
2153	EU152	1977	INSITU	3.94	4.88	0.00	NCI/M2	LASL77	
2131	EU152	1977	INSITU	6.62	1.87	0.00	NCI/M2	LASL77	
2090	EU152	1977	INSITU	13.85	7.69	0.00	NCI/M2	LASL77	
2030	EU152	1977	INSITU	10.39	4.30	0.00	NCI/M2	LASL77	
2048	EU152	1977	INSITU	11.09	5.87	0.00	NCI/M2	LASL77	
2055	EU152	1977	INSITU	11.35	5.86	0.00	NCI/M2	LASL77	
2072	EU152	1977	INSITU	9.86	4.42	0.00	NCI/M2	LASL77	
2023	EU152	1977	INSITU	9.54	3.98	23.60	NCI/M2	LASL77	
2025	EU152	1977	INSITU	10.12	4.27	0.00	NCI/M2	LASL77	
2084	EU152	1977	INSITU	12.58	7.17	0.00	NCI/M2	LASL77	
2116	EU152	1977	INSITU	13.74	6.12	0.00	NCI/M2	LASL77	
2101	EU152	1977	INSITU	16.52	14.74	0.00	NCI/M2	LASL77	
2115	EU152	1977	INSITU	13.57	6.49	0.00	NCI/M2	LASL77	
2093	EU152	1977	INSITU	14.60	8.57	0.00	NCI/M2	LASL77	
2077	EU152	1977	INSITU	10.31	4.41	0.00	NCI/M2	LASL77	
2075	EU152	1977	INSITU	10.85	4.60	0.00	NCI/M2	LASL77	
2130	EU152	1977	INSITU	6.03	.60	0.00	NCI/M2	LASL77	
2073	EU152	1977	INSITU	9.86	4.42	0.00	NCI/M2	LASL77	
2033	EU152	1977	INSITU	3.14	3.57	0.00	NCI/M2	LASL77	
2047	EU152	1977	INSITU	11.08	5.74	0.00	NCI/M2	LASL77	
2050	EU152	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77	
2123	EU152	1977	INSITU	13.68	6.79	0.00	NCI/M2	LASL77	
2068	EU152	1977	INSITU	9.30	5.02	0.00	NCI/M2	LASL77	
2029	EU152	1977	INSITU	10.35	4.28	0.00	NCI/M2	LASL77	
2083	EU152	1977	INSITU	12.14	7.19	0.00	NCI/M2	LASL77	
2061	EU152	1977	INSITU	9.91	5.07	0.00	NCI/M2	LASL77	
2049	EU152	1977	SG	11.11	5.55	0.00	PCI/GM	LLL	GELI
2007	EU152	1977	SK	7.10	2.07	0.00	PCI/GM	LLL	GELI
1987	EU152	1977	SK	6.63	.55	1.31	PCI/GM	LLL	GELI
1991	EU152	1977	SK	6.63	.55	.53	PCI/GM	LLL	GELI
2045	EU152	1977	SK	10.52	5.51	0.00	PCI/GM	LLL	GELI
2016	EU152	1977	SK	7.24	2.33	0.00	PCI/GM	LLL	GELI
2028	EU152	1977	TH	10.37	4.33	0.00	PCI/GM	LLL	GELI
2052	EU152	1977	UK	11.11	5.55	0.00	PCI/GM	LLL	GELI
1988	EU154	1977	GR	6.64	.55	0.00	PCI/GM	LLL	GELI
2055	EU154	1977	GR	11.35	5.86	0.00	PCI/GM	LLL	GELI
1990	EU154	1977	GR	6.64	.55	0.00	PCI/GM	LLL	GELI
2018	EU154	1977	GR	6.66	1.76	0.00	PCI/GM	LLL	GELI
2049	EU154	1977	SG	11.11	5.55	0.00	PCI/GM	LLL	GELI
1987	EU154	1977	SK	6.63	.55	.20	PCI/GM	LLL	GELI
2007	EU154	1977	SK	7.10	2.07	0.00	PCI/GM	LLL	GELI
1991	EU154	1977	SK	6.63	.55	0.00	PCI/GM	LLL	GELI
2045	EU154	1977	SK	10.52	5.51	0.00	PCI/GM	LLL	GELI
2016	EU154	1977	SK	7.24	2.33	0.00	PCI/GM	LLL	GELI
2028	EU154	1977	TH	10.37	4.33	0.00	PCI/GM	LLL	GELI
2052	EU154	1977	UK	11.11	5.55	0.00	PCI/GM	LLL	GELI
2100	EU155	1977	INSITU	14.50	12.20	0.00	NCI/M2	LASL77	
2010	EU155	1977	INSITU	6.79	1.71	0.00	NCI/M2	LASL77	
2115	EU155	1977	INSITU	13.57	6.49	0.00	NCI/M2	LASL77	
2037	EU155	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77	
2018	EU155	1977	INSITU	6.66	1.76	0.00	NCI/M2	LASL77	
2032	EU155	1977	INSITU	3.17	3.48	0.00	NCI/M2	LASL77	
2013	EU155	1977	INSITU	7.43	2.11	0.00	NCI/M2	LASL77	
2052	EU155	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77	
2143	EU155	1977	INSITU	4.81	3.00	0.00	NCI/M2	LASL77	
2020	EU155	1977	INSITU	3.17	3.48	0.00	NCI/M2	LASL77	
1998	EU155	1977	INSITU	6.63	.55	0.00	NCI/M2	LASL77	
2031	EU155	1977	INSITU	10.41	4.28	0.00	NCI/M2	LASL77	
2006	EU155	1977	INSITU	7.07	2.04	0.00	NCI/M2	LASL77	
2034	EU155	1977	INSITU	3.16	3.70	0.00	NCI/M2	LASL77	
2128	EU155	1977	INSITU	13.77	5.47	41.16	NCI/M2	LASL77	

2012	EU155	1977	INSITU	6.79	1.77	81.60	NCI/M2	LASL77
2092	EU155	1977	INSITU	13.52	9.21	0.00	NCI/M2	LASL77
2072	EU155	1977	INSITU	9.86	4.42	0.00	NCI/M2	LASL77
2019	EU155	1977	INSITU	6.69	2.24	0.00	NCI/M2	LASL77
2067	EU155	1977	INSITU	9.31	4.96	0.00	NCI/M2	LASL77
2049	EU155	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2132	EU155	1977	INSITU	6.70	2.16	0.00	NCI/M2	LASL77
2084	EU155	1977	INSITU	12.58	7.17	0.00	NCI/M2	LASL77
2015	EU155	1977	INSITU	7.37	2.31	0.00	NCI/M2	LASL77
2141	EU155	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2059	EU155	1977	INSITU	9.74	5.42	0.00	NCI/M2	LASL77
2050	EU155	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2080	EU155	1977	INSITU	10.91	7.22	0.00	NCI/M2	LASL77
2085	EU155	1977	INSITU	12.60	6.58	0.00	NCI/M2	LASL77
2123	EU155	1977	INSITU	13.68	6.79	0.00	NCI/M2	LASL77
2009	EU155	1977	INSITU	6.59	1.65	0.00	NCI/M2	LASL77
2064	EU155	1977	INSITU	10.54	7.19	0.00	NCI/M2	LASL77
2155	EU155	1977	INSITU	3.91	3.49	0.00	NCI/M2	LASL77
2118	EU155	1977	INSITU	14.55	6.45	0.00	NCI/M2	LASL77
2073	EU155	1977	INSITU	9.86	4.42	0.00	NCI/M2	LASL77
2016	EU155	1977	INSITU	7.24	2.33	0.00	NCI/M2	LASL77
2057	EU155	1977	INSITU	10.35	5.34	0.00	NCI/M2	LASL77
2042	EU155	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77
2008	EU155	1977	INSITU	7.40	2.10	0.00	NCI/M2	LASL77
2086	EU155	1977	INSITU	10.53	7.19	0.00	NCI/M2	LASL77
2022	EU155	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
2027	EU155	1977	INSITU	10.28	4.20	0.00	NCI/M2	LASL77
2014	EU155	1977	INSITU	7.37	2.22	0.00	NCI/M2	LASL77
2127	EU155	1977	INSITU	13.40	5.21	0.00	NCI/M2	LASL77
2038	EU155	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
2122	EU155	1977	INSITU	13.69	6.87	0.00	NCI/M2	LASL77
2053	EU155	1977	INSITU	10.69	5.56	0.00	NCI/M2	LASL77
2065	EU155	1977	INSITU	10.39	5.01	0.00	NCI/M2	LASL77
2071	EU155	1977	INSITU	9.83	4.48	0.00	NCI/M2	LASL77
2047	EU155	1977	INSITU	11.08	5.74	0.00	NCI/M2	LASL77
2138	EU155	1977	INSITU	5.81	2.17	0.00	NCI/M2	LASL77
2033	EU155	1977	INSITU	3.14	3.57	0.00	NCI/M2	LASL77
2026	EU155	1977	INSITU	10.05	4.07	55.10	NCI/M2	LASL77
2153	EU155	1977	INSITU	3.94	4.88	0.00	NCI/M2	LASL77
2119	EU155	1977	INSITU	14.34	7.21	0.00	NCI/M2	LASL77
2048	EU155	1977	INSITU	11.09	5.87	0.00	NCI/M2	LASL77
1997	EU155	1977	INSITU	6.46	1.16	0.00	NCI/M2	LASL77
2039	EU155	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
2061	EU155	1977	INSITU	9.91	5.07	0.00	NCI/M2	LASL77
2041	EU155	1977	INSITU	9.61	4.32	0.00	NCI/M2	LASL77
2075	EU155	1977	INSITU	10.85	4.60	0.00	NCI/M2	LASL77
2094	EU155	1977	INSITU	14.49	9.25	0.00	NCI/M2	LASL77
2024	EU155	1977	INSITU	8.95	3.88	0.00	NCI/M2	LASL77
1996	EU155	1977	INSITU	6.45	.75	0.00	NCI/M2	LASL77
2025	EU155	1977	INSITU	10.12	4.27	0.00	NCI/M2	LASL77
2060	EU155	1977	INSITU	9.91	5.07	0.00	NCI/M2	LASL77
2077	EU155	1977	INSITU	10.31	4.41	0.00	NCI/M2	LASL77
2066	EU155	1977	INSITU	10.60	4.42	64.00	NCI/M2	LASL77
2007	EU155	1977	INSITU	7.10	2.07	0.00	NCI/M2	LASL77
2090	EU155	1977	INSITU	13.85	7.69	0.00	NCI/M2	LASL77
2028	EU155	1977	INSITU	10.37	4.33	86.00	NCI/M2	LASL77
2043	EU155	1977	INSITU	3.91	3.49	0.00	NCI/M2	LASL77
2062	EU155	1977	INSITU	9.83	5.10	0.00	NCI/M2	LASL77
2146	EU155	1977	INSITU	9.82	4.27	0.00	NCI/M2	LASL77
2140	EU155	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2135	EU155	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2058	EU155	1977	INSITU	10.00	5.31	0.00	NCI/M2	LASL77
2029	EU155	1977	INSITU	10.35	4.28	0.00	NCI/M2	LASL77
2079	EU155	1977	INSITU	10.53	7.20	0.00	NCI/M2	LASL77
2121	EU155	1977	INSITU	13.68	6.87	0.00	NCI/M2	LASL77
2116	EU155	1977	INSITU	13.74	6.12	0.00	NCI/M2	LASL77
2125	EU155	1977	INSITU	14.68	4.45	0.00	NCI/M2	LASL77
2017	EU155	1977	INSITU	7.25	2.33	0.00	NCI/M2	LASL77
2129	EU155	1977	INSITU	6.27	0.00	0.00	NCI/M2	LASL77
2074	EU155	1977	INSITU	9.85	4.35	0.00	NCI/M2	LASL77
2083	EU155	1977	INSITU	12.14	7.19	0.00	NCI/M2	LASL77
2131	EU155	1977	INSITU	6.62	1.87	0.00	NCI/M2	LASL77
2134	EU155	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2147	EU155	1977	INSITU	7.77	3.07	0.00	NCI/M2	LASL77
2097	EU155	1977	INSITU	15.45	9.75	0.00	NCI/M2	LASL77
2023	EU155	1977	INSITU	9.54	3.98	0.00	NCI/M2	LASL77
2088	EU155	1977	INSITU	13.22	7.66	0.00	NCI/M2	LASL77
2082	EU155	1977	INSITU	11.62	7.18	0.00	NCI/M2	LASL77
2139	EU155	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2087	EU155	1977	INSITU	12.92	7.66	0.00	NCI/M2	LASL77

2154	EU155	1977	INSITU	3.95	4.57	0.00	NCI/M2	LASL77
2099	EU155	1977	INSITU	11.12	10.93	0.00	NCI/M2	LASL77
2144	EU155	1977	INSITU	10.46	7.19	0.00	NCI/M2	LASL77
2076	EU155	1977	INSITU	11.09	4.52	0.00	NCI/M2	LASL77
2095	EU155	1977	INSITU	14.49	9.25	0.00	NCI/M2	LASL77
2093	EU155	1977	INSITU	14.60	8.57	0.00	NCI/M2	LASL77
2040	EU155	1977	INSITU	9.60	4.32	0.00	NCI/M2	LASL77
2136	EU155	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2120	EU155	1977	INSITU	14.30	7.16	0.00	NCI/M2	LASL77
2081	EU155	1977	INSITU	11.31	7.21	0.00	NCI/M2	LASL77
2068	EU155	1977	INSITU	9.30	5.02	0.00	NCI/M2	LASL77
2030	EU155	1977	INSITU	10.39	4.30	0.00	NCI/M2	LASL77
2096	EU155	1977	INSITU	14.49	9.24	0.00	NCI/M2	LASL77
2126	EU155	1977	INSITU	12.45	4.27	0.00	NCI/M2	LASL77
2148	EU155	1977	INSITU	2.98	3.62	0.00	NCI/M2	LASL77
2011	EU155	1977	INSITU	6.32	.00	40.20	NCI/M2	LASL77
2055	EU155	1977	INSITU	11.35	5.86	0.00	NCI/M2	LASL77
2130	EU155	1977	INSITU	6.03	.60	0.00	NCI/M2	LASL77
2114	EU155	1977	INSITU	10.46	7.18	0.00	NCI/M2	LASL77
2101	EU155	1977	INSITU	16.52	14.74	0.00	NCI/M2	LASL77
2142	EU155	1977	INSITU	6.27	.00	0.00	NCI/M2	LASL77
2067	G-NAT	1977	INSITU	9.31	4.96	6.37	UR/HR	LASL77
2079	G-NAT	1977	INSITU	10.53	7.20	5.19	UR/HR	LASL77
2086	G-NAT	1977	INSITU	10.53	7.19	4.75	UR/HR	LASL77
2033	G-NAT	1977	INSITU	3.14	3.57	8.05	UR/HR	LASL77
2016	G-NAT	1977	INSITU	7.24	2.33	11.10	UR/HR	LASL77
2121	G-NAT	1977	INSITU	13.68	6.87	15.11	UR/HR	LASL77
2010	G-NAT	1977	INSITU	6.79	1.71	6.42	UR/HR	LASL77
1998	G-NAT	1977	INSITU	6.63	.55	9.57	UR/HR	LASL77
2093	G-NAT	1977	INSITU	14.60	8.57	6.75	UR/HR	LASL77
2114	G-NAT	1977	INSITU	10.46	7.18	4.72	UR/HR	LASL77
2129	G-NAT	1977	INSITU	6.27	0.00	7.70	UR/HR	LASL77
2058	G-NAT	1977	INSITU	10.00	5.31	5.21	UR/HR	LASL77
2072	G-NAT	1977	INSITU	9.86	4.42	8.93	UR/HR	LASL77
2080	G-NAT	1977	INSITU	10.91	7.22	5.30	UR/HR	LASL77
2140	G-NAT	1977	INSITU	6.58	.55	8.39	UR/HR	LASL77
2007	G-NAT	1977	INSITU	7.10	2.07	6.82	UR/HR	LASL77
2018	G-NAT	1977	INSITU	6.66	1.76	6.94	UR/HR	LASL77
2088	G-NAT	1977	INSITU	13.22	7.66	9.01	UR/HR	LASL77
2087	G-NAT	1977	INSITU	12.92	7.66	8.75	UR/HR	LASL77
2019	G-NAT	1977	INSITU	6.69	2.24	5.38	UR/HR	LASL77
2023	G-NAT	1977	INSITU	9.54	3.98	7.89	UR/HR	LASL77
2128	G-NAT	1977	INSITU	13.77	5.47	9.30	UR/HR	LASL77
2134	G-NAT	1977	INSITU	6.58	.55	6.46	UR/HR	LASL77
2064	G-NAT	1977	INSITU	10.54	7.19	4.76	UR/HR	LASL77
2100	G-NAT	1977	INSITU	14.50	12.20	8.09	UR/HR	LASL77
2144	G-NAT	1977	INSITU	10.46	7.19	3.87	UR/HR	LASL77
2040	G-NAT	1977	INSITU	9.60	4.32	5.72	UR/HR	LASL77
2081	G-NAT	1977	INSITU	11.31	7.21	6.15	UR/HR	LASL77
2135	G-NAT	1977	INSITU	6.58	.55	9.98	UR/HR	LASL77
2062	G-NAT	1977	INSITU	9.83	5.10	7.06	UR/HR	LASL77
2030	G-NAT	1977	INSITU	10.39	4.30	8.05	UR/HR	LASL77
2066	G-NAT	1977	INSITU	10.60	4.42	8.82	UR/HR	LASL77
2155	G-NAT	1977	INSITU	3.91	3.49	7.02	UR/HR	LASL77
2120	G-NAT	1977	INSITU	14.30	7.16	8.83	UR/HR	LASL77
2009	G-NAT	1977	INSITU	6.59	1.65	9.11	UR/HR	LASL77
2082	G-NAT	1977	INSITU	11.62	7.18	8.07	UR/HR	LASL77
2125	G-NAT	1977	INSITU	14.68	4.45	11.56	UR/HR	LASL77
2073	G-NAT	1977	INSITU	9.86	4.42	9.69	UR/HR	LASL77
2052	G-NAT	1977	INSITU	11.11	5.55	9.69	UR/HR	LASL77
2083	G-NAT	1977	INSITU	12.14	7.19	4.75	UR/HR	LASL77
2017	G-NAT	1977	INSITU	7.25	2.33	11.56	UR/HR	LASL77
2085	G-NAT	1977	INSITU	12.60	6.58	7.03	UR/HR	LASL77
2041	G-NAT	1977	INSITU	9.61	4.32	6.54	UR/HR	LASL77
2097	G-NAT	1977	INSITU	15.45	9.75	8.55	UR/HR	LASL77
2024	G-NAT	1977	INSITU	8.95	3.88	8.31	UR/HR	LASL77
2034	G-NAT	1977	INSITU	3.16	3.70	8.69	UR/HR	LASL77
2020	G-NAT	1977	INSITU	3.17	3.48	9.93	UR/HR	LASL77
2068	G-NAT	1977	INSITU	9.30	5.02	8.06	UR/HR	LASL77
2060	G-NAT	1977	INSITU	9.91	5.07	9.48	UR/HR	LASL77
2092	G-NAT	1977	INSITU	13.52	9.21	3.70	UR/HR	LASL77
2011	G-NAT	1977	INSITU	6.32	.00	8.96	UR/HR	LASL77
2022	G-NAT	1977	INSITU	9.60	4.32	7.22	UR/HR	LASL77
2013	G-NAT	1977	INSITU	7.43	2.11	9.78	UR/HR	LASL77
2096	G-NAT	1977	INSITU	14.49	9.24	6.67	UR/HR	LASL77
2059	G-NAT	1977	INSITU	9.74	5.42	7.68	UR/HR	LASL77
2074	G-NAT	1977	INSITU	9.85	4.35	6.41	UR/HR	LASL77
2049	G-NAT	1977	INSITU	11.11	5.55	5.82	UR/HR	LASL77
2148	G-NAT	1977	INSITU	2.98	3.62	8.38	UR/HR	LASL77
2043	G-NAT	1977	INSITU	3.91	3.49	6.37	UR/HR	LASL77

2116	G-NAT	1977	INSITU	13.74	6.12	9.16	UR/HR	LASL77
2075	G-NAT	1977	INSITU	10.85	4.60	6.05	UR/HR	LASL77
2142	G-NAT	1977	INSITU	6.27	.00	7.68	UR/HR	LASL77
2031	G-NAT	1977	INSITU	10.41	4.28	6.07	UR/HR	LASL77
1996	G-NAT	1977	INSITU	6.45	.75	9.13	UR/HR	LASL77
2130	G-NAT	1977	INSITU	6.03	.60	9.16	UR/HR	LASL77
2136	G-NAT	1977	INSITU	6.58	.55	5.47	UR/HR	LASL77
2047	G-NAT	1977	INSITU	11.08	5.74	7.17	UR/HR	LASL77
2077	G-NAT	1977	INSITU	10.31	4.41	7.29	UR/HR	LASL77
2008	G-NAT	1977	INSITU	7.40	2.10	15.99	UR/HR	LASL77
2138	G-NAT	1977	INSITU	5.81	2.17	1.55	UR/HR	LASL77
1997	G-NAT	1977	INSITU	6.46	1.16	4.56	UR/HR	LASL77
2037	G-NAT	1977	INSITU	9.82	4.27	9.27	UR/HR	LASL77
2042	G-NAT	1977	INSITU	9.82	4.27	9.69	UR/HR	LASL77
2095	G-NAT	1977	INSITU	14.49	9.25	5.83	UR/HR	LASL77
2025	G-NAT	1977	INSITU	10.12	4.27	6.22	UR/HR	LASL77
2027	G-NAT	1977	INSITU	10.28	4.20	4.36	UR/HR	LASL77
2057	G-NAT	1977	INSITU	10.35	5.34	7.36	UR/HR	LASL77
2127	G-NAT	1977	INSITU	13.40	5.21	7.87	UR/HR	LASL77
2147	G-NAT	1977	INSITU	7.77	3.07	5.42	UR/HR	LASL77
2118	G-NAT	1977	INSITU	14.55	6.45	8.82	UR/HR	LASL77
2026	G-NAT	1977	INSITU	10.05	4.07	8.56	UR/HR	LASL77
2141	G-NAT	1977	INSITU	6.58	.55	8.74	UR/HR	LASL77
2143	G-NAT	1977	INSITU	4.81	3.00	5.72	UR/HR	LASL77
2146	G-NAT	1977	INSITU	9.82	4.27	3.46	UR/HR	LASL77
2132	G-NAT	1977	INSITU	6.70	2.16	4.72	UR/HR	LASL77
2123	G-NAT	1977	INSITU	13.68	6.79	12.60	UR/HR	LASL77
2038	G-NAT	1977	INSITU	9.60	4.32	5.73	UR/HR	LASL77
2061	G-NAT	1977	INSITU	9.91	5.07	9.96	UR/HR	LASL77
2076	G-NAT	1977	INSITU	11.09	4.52	3.85	UR/HR	LASL77
2153	G-NAT	1977	INSITU	3.94	4.88	5.50	UR/HR	LASL77
2039	G-NAT	1977	INSITU	9.60	4.32	5.98	UR/HR	LASL77
2119	G-NAT	1977	INSITU	14.34	7.21	6.71	UR/HR	LASL77
2048	G-NAT	1977	INSITU	11.09	5.87	6.97	UR/HR	LASL77
2101	G-NAT	1977	INSITU	16.52	14.74	6.87	UR/HR	LASL77
2139	G-NAT	1977	INSITU	6.58	.55	8.14	UR/HR	LASL77
2090	G-NAT	1977	INSITU	13.85	7.69	14.08	UR/HR	LASL77
2154	G-NAT	1977	INSITU	3.95	4.57	4.79	UR/HR	LASL77
2131	G-NAT	1977	INSITU	6.62	1.87	6.77	UR/HR	LASL77
2014	G-NAT	1977	INSITU	7.37	2.22	11.02	UR/HR	LASL77
2126	G-NAT	1977	INSITU	12.45	4.27	7.09	UR/HR	LASL77
2084	G-NAT	1977	INSITU	12.58	7.17	8.11	UR/HR	LASL77
2065	G-NAT	1977	INSITU	10.39	5.01	5.96	UR/HR	LASL77
2006	G-NAT	1977	INSITU	7.07	2.04	5.40	UR/HR	LASL77
2071	G-NAT	1977	INSITU	9.83	4.48	7.56	UR/HR	LASL77
2115	G-NAT	1977	INSITU	13.57	6.49	8.65	UR/HR	LASL77
2029	G-NAT	1977	INSITU	10.35	4.28	7.60	UR/HR	LASL77
2029	G-NAT	1977	INSITU	10.35	4.28	8.10	UR/HR	LASL77
2094	G-NAT	1977	INSITU	14.49	9.25	7.01	UR/HR	LASL77
2055	G-NAT	1977	INSITU	11.35	5.86	7.03	UR/HR	LASL77
2050	G-NAT	1977	INSITU	11.11	5.55	5.64	UR/HR	LASL77
2015	G-NAT	1977	INSITU	7.37	2.31	2.87	UR/HR	LASL77
2012	G-NAT	1977	INSITU	6.79	1.77	9.47	UR/HR	LASL77
2099	G-NAT	1977	INSITU	11 12	10.93	3.96	UR/HR	LASL77
2053	G-NAT	1977	INSITU	10.69	5.56	4.46	UR/HR	LASL77
2138	G-NAT	1977	INSITU	5.81	2.17	8.15	UR/HR	LASL77
2032	G-NAT	1977	INSITU	3.17	3.48	8.79	UR/HR	LASL77
2101	G-TOT	1977	INSITU	16.52	14.74	7.34	UR/HR	LASL77
2093	G-TOT	1977	INSITU	14.60	8.57	7.54	UR/HR	LASL77
2065	G-TOT	1977	INSITU	10.39	5.01	7.01	UR/HR	LASL77
2015	G-TOT	1977	INSITU	7.37	2.31	3.29	UR/HR	LASL77
2096	G-TOT	1977	INSITU	14.49	9.24	7.25	UR/HR	LASL77
2087	G-TOT	1977	INSITU	12.92	7.86	9.75	UR/HR	LASL77
2144	G-TOT	1977	INSITU	10.46	7.19	4.12	UR/HR	LASL77
2027	G-TOT	1977	INSITU	10.28	4.20	5.67	UR/HR	LASL77
2014	G-TOT	1977	INSITU	7.37	2.22	11.47	UR/HR	LASL77
2082	G-TOT	1977	INSITU	11.62	7.18	8.89	UR/HR	LASL77
2011	G-TOT	1977	INSITU	6.32	.00	9.28	UR/HR	LASL77
2052	G-TOT	1977	INSITU	11.11	5.55	10.23	UR/HR	LASL77
2012	G-TOT	1977	INSITU	6.79	1.77	10.46	UR/HR	LASL77
2138	G-TOT	1977	INSITU	5.81	2.17	1.79	UR/HR	LASL77
2143	G-TOT	1977	INSITU	4.81	3.00	5.89	UR/HR	LASL77
1998	G-TOT	1977	INSITU	6.63	.55	10.60	UR/HR	LASL77
2067	G-TOT	1977	INSITU	9.31	4.96	7.04	UR/HR	LASL77
2136	G-TOT	1977	INSITU	6.58	.55	174.70	UR/HR	LASL77
2068	G-TOT	1977	INSITU	9.30	5.02	9.14	UR/HR	LASL77
2148	G-TOT	1977	INSITU	2.98	3.62	8.62	UR/HR	LASL77
2018	G-TOT	1977	INSITU	5.66	1.76	7.36	UR/HR	LASL77
2095	G-TOT	1977	INSITU	14.49	9.25	6.26	UR/HR	LASL77
2132	G-TOT	1977	INSITU	6.70	2.16	4.91	UR/HR	LASL77

2058	G-TOT	1977	INSITU	10.00	5.31	9.85	UR/HR	LASL77
2038	G-TOT	1977	INSITU	9.60	4.32	7.49	UR/HR	LASL77
2071	G-TOT	1977	INSITU	9.83	4.48	9.53	UR/HR	LASL77
2074	G-TOT	1977	INSITU	9.85	4.35	7.75	UR/HR	LASL77
2024	G-TOT	1977	INSITU	8.95	3.88	8.93	UR/HR	LASL77
2039	G-TOT	1977	INSITU	9.60	4.32	8.14	UR/HR	LASL77
2120	G-TOT	1977	INSITU	14.30	7.16	9.65	UR/HR	LASL77
2141	G-TOT	1977	INSITU	6.58	.55	10.34	UR/HR	LASL77
2072	G-TOT	1977	INSITU	9.86	4.42	12.65	UR/HR	LASL77
2033	G-TOT	1977	INSITU	3.14	3.57	8.22	UR/HR	LASL77
2092	G-TOT	1977	INSITU	13.52	9.21	4.07	UR/HR	LASL77
2153	G-TOT	1977	INSITU	3.94	4.88	5.76	UR/HR	LASL77
2009	G-TOT	1977	INSITU	6.59	1.65	10.15	UR/HR	LASL77
2019	G-TOT	1977	INSITU	6.69	2.24	5.62	UR/HR	LASL77
2017	G-TOT	1977	INSITU	7.25	2.33	11.78	UR/HR	LASL77
2049	G-TOT	1977	INSITU	11.11	5.55	6.44	UR/HR	LASL77
2077	G-TOT	1977	INSITU	10.31	4.41	7.67	UR/HR	LASL77
2086	G-TOT	1977	INSITU	10.53	7.19	5.08	UR/HR	LASL77
2037	G-TOT	1977	INSITU	9.82	4.27	12.03	UR/HR	LASL77
2123	G-TOT	1977	INSITU	13.68	6.79	13.24	UR/HR	LASL77
2022	G-TOT	1977	INSITU	9.60	4.32	9.70	UR/HR	LASL77
2047	G-TOT	1977	INSITU	11.08	5.74	7.92	UR/HR	LASL77
2130	G-TOT	1977	INSITU	6.03	.60	9.89	UR/HR	LASL77
2050	G-TOT	1977	INSITU	11.11	5.55	6.17	UR/HR	LASL77
2025	G-TOT	1977	INSITU	10.12	4.27	6.59	UR/HR	LASL77
2146	G-TOT	1977	INSITU	9.82	4.27	5.48	UR/HR	LASL77
2055	G-TOT	1977	INSITU	11.35	5.86	7.23	UR/HR	LASL77
2147	G-TOT	1977	INSITU	7.77	3.07	5.69	UR/HR	LASL77
2007	G-TOT	1977	INSITU	7.10	2.07	7.57	UR/HR	LASL77
2075	G-TOT	1977	INSITU	10.85	4.60	6.34	UR/HR	LASL77
2114	G-TOT	1977	INSITU	10.46	7.18	5.04	UR/HR	LASL77
2076	G-TOT	1977	INSITU	11.09	4.52	4.52	UR/HR	LASL77
2026	G-TOT	1977	INSITU	10.05	4.07	11.33	UR/HR	LASL77
2119	G-TOT	1977	INSITU	14.34	7.21	7.19	UR/HR	LASL77
2134	G-TOT	1977	INSITU	6.58	.55	171.20	UR/HR	LASL77
2023	G-TOT	1977	INSITU	9.54	3.98	9.59	UR/HR	LASL77
2115	G-TOT	1977	INSITU	13.57	6.49	9.25	UR/HR	LASL77
2053	G-TOT	1977	INSITU	10.69	5.56	5.25	UR/HR	LASL77
2129	G-TOT	1977	INSITU	6.27	0.00	7.95	UR/HR	LASL77
2059	G-TOT	1977	INSITU	9.74	5.42	8.81	UR/HR	LASL77
2126	G-TOT	1977	INSITU	12.45	4.27	7.48	UR/HR	LASL77
2081	G-TOT	1977	INSITU	11.31	7.21	6.95	UR/HR	LASL77
2040	G-TOT	1977	INSITU	9.60	4.32	7.34	UR/HR	LASL77
2080	G-TOT	1977	INSITU	10.91	7.22	5.72	UR/HR	LASL77
2138	G-TOT	1977	INSITU	5.81	2.17	10.34	UR/HR	LASL77
2066	G-TOT	1977	INSITU	10.60	4.42	10.17	UR/HR	LASL77
2057	G-TOT	1977	INSITU	10.35	5.34	8.24	UR/HR	LASL77
2032	G-TOT	1977	INSITU	3.17	3.48	9.17	UR/HR	LASL77
1996	G-TOT	1977	INSITU	6.45	.75	9.32	UR/HR	LASL77
2094	G-TOT	1977	INSITU	14.49	9.25	7.62	UR/HR	LASL77
2061	G-TOT	1977	INSITU	9.91	5.07	10.66	UR/HR	LASL77
2030	G-TOT	1977	INSITU	10.39	4.30	10.98	UR/HR	LASL77
2060	G-TOT	1977	INSITU	9.91	5.07	11.09	UR/HR	LASL77
2010	G-TOT	1977	INSITU	6.79	1.71	6.83	UR/HR	LASL77
2118	G-TOT	1977	INSITU	14.55	6.45	9.52	UR/HR	LASL77
2097	G-TOT	1977	INSITU	15.45	9.75	8.97	UR/HR	LASL77
2100	G-TOT	1977	INSITU	14.50	12.20	8.51	UR/HR	LASL77
2006	G-TOT	1977	INSITU	7.07	2.04	6.20	UR/HR	LASL77
2135	G-TOT	1977	INSITU	6.58	.55	397.00	UR/HR	LASL77
2042	G-TOT	1977	INSITU	9.82	4.27	12.25	UR/HR	LASL77
2121	G-TOT	1977	INSITU	13.68	6.87	15.95	UR/HR	LASL77
2079	G-TOT	1977	INSITU	10.53	7.20	5.53	UR/HR	LASL77
2083	G-TOT	1977	INSITU	12.14	7.19	5.67	UR/HR	LASL77
2155	G-TOT	1977	INSITU	3.91	3.49	7.27	UR/HR	LASL77
2127	G-TOT	1977	INSITU	13.40	5.21	8.08	UR/HR	LASL77
2099	G-TOT	1977	INSITU	11.12	10.93	4.32	UR/HR	LASL77
2085	G-TOT	1977	INSITU	12.60	6.58	8.04	UR/HR	LASL77
2013	G-TOT	1977	INSITU	7.43	2.11	9.98	UR/HR	LASL77
2029	G-TOT	1977	INSITU	10.35	4.28	7.89	UR/HR	LASL77
2088	G-TOT	1977	INSITU	13.22	7.66	9.93	UR/HR	LASL77
2116	G-TOT	1977	INSITU	13.74	6.12	9.78	UR/HR	LASL77
2064	G-TOT	1977	INSITU	10.54	7.19	5.08	UR/HR	LASL77
2125	G-TOT	1977	INSITU	14.68	4.45	12.20	UR/HR	LASL77
2131	G-TOT	1977	INSITU	6.62	1.87	6.97	UR/HR	LASL77
2140	G-TOT	1977	INSITU	6.58	.55	9.77	UR/HR	LASL77
2008	G-TOT	1977	INSITU	7.40	2.10	6.24	UR/HR	LASL77
2031	G-TOT	1977	INSITU	10.41	4.28	7.44	UR/HR	LASL77
2139	G-TOT	1977	INSITU	6.58	.55	21.95	UR/HR	LASL77
2128	G-TOT	1977	INSITU	13.77	5.47	9.79	UR/HR	LASL77
2034	G-TOT	1977	INSITU	3.16	3.70	8.89	UR/HR	LASL77

2020	G-TOT	1977	INSITU	3.17	3.48	9.95	UR/HR	LASL77
2154	G-TOT	1977	INSITU	3.95	4.57	5.16	UR/HR	LASL77
2090	G-TOT	1977	INSITU	13.85	7.69	14.68	UR/HR	LASL77
2062	G-TOT	1977	INSITU	9.83	5.10	8.25	UR/HR	LASL77
2041	G-TOT	1977	INSITU	9.61	4.32	8.74	UR/HR	LASL77
2142	G-TOT	1977	INSITU	6.27	.00	7.90	UR/HR	LASL77
2084	G-TOT	1977	INSITU	12.58	7.17	8.89	UR/HR	LASL77
2043	G-TOT	1977	INSITU	3.91	3.49	6.42	UR/HR	LASL77
2016	G-TOT	1977	INSITU	7.24	2.33	11.50	UR/HR	LASL77
2048	G-TOT	1977	INSITU	11.09	5.87	7.55	UR/HR	LASL77
1997	G-TOT	1977	INSITU	6.46	1.16	4.69	UR/HR	LASL77
2029	G-TOT	1977	INSITU	10.35	4.28	11.72	UR/HR	LASL77
2073	G-TOT	1977	INSITU	9.86	4.42	12.42	UR/HR	LASL77
2061	K40	1977	INSITU	9.91	5.07	24.10	PCI/GM	LASL77
2115	K40	1977	INSITU	13.57	6.49	21.50	PCI/GM	LASL77
2073	K40	1977	INSITU	9.86	4.42	22.60	PCI/GM	LASL77
2130	K40	1977	INSITU	6.03	.60	18.50	PCI/GM	LASL77
2154	K40	1977	INSITU	3.95	4.57	11.79	PCI/GM	LASL77
2118	K40	1977	INSITU	14.55	6.45	19.40	PCI/GM	LASL77
2011	K40	1977	INSITU	6.32	.00	24.30	PCI/GM	LASL77
2127	K40	1977	INSITU	13.40	5.21	15.90	PCI/GM	LASL77
2009	K40	1977	INSITU	6.59	1.65	16.65	PCI/GM	LASL77
2144	K40	1977	INSITU	10.46	7.19	12.40	PCI/GM	LASL77
2083	K40	1977	INSITU	12.14	7.19	9.90	PCI/GM	LASL77
2043	K40	1977	INSITU	3.91	3.49	14.29	PCI/GM	LASL77
2055	K40	1977	INSITU	11.35	5.86	16.50	PCI/GM	LASL77
2029	K40	1977	INSITU	10.35	4.28	18.57	PCI/GM	LASL77
2134	K40	1977	INSITU	6.58	.55	14.68	PCI/GM	LASL77
2119	K40	1977	INSITU	14.34	7.31	17.32	PCI/GM	LASL77
2077	K40	1977	INSITU	10.31	4.41	17.08	PCI/GM	LASL77
2064	K40	1977	INSITU	10.54	7.19	14.56	PCI/GM	LASL77
2140	K40	1977	INSITU	6.58	.55	23.90	PCI/GM	LASL77
2034	K40	1977	INSITU	3.16	3.70	19.16	PCI/GM	LASL77
2065	K40	1977	INSITU	10.39	5.01	13.80	PCI/GM	LASL77
1998	K40	1977	INSITU	6.63	.55	29.90	PCI/GM	LASL77
2128	K40	1977	INSITU	13.77	5.47	18.30	PCI/GM	LASL77
2146	K40	1977	INSITU	9.82	4.27	6.41	PCI/GM	LASL77
2023	K40	1977	INSITU	9.54	3.98	17.30	PCI/GM	LASL77
2101	K40	1977	INSITU	16.52	14.74	14.90	PCI/GM	LASL77
2123	K40	1977	INSITU	13.68	6.79	28.40	PCI/GM	LASL77
2047	K40	1977	INSITU	11.08	5.74	12.89	PCI/GM	LASL77
2032	K40	1977	INSITU	3.17	3.48	17.10	PCI/GM	LASL77
2116	K40	1977	INSITU	13.74	6.12	19.60	PCI/GM	LASL77
2018	K40	1977	INSITU	6.66	1.76	20.40	PCI/GM	LASL77
2084	K40	1977	INSITU	12.58	7.17	18.30	PCI/GM	LASL77
2008	K40	1977	INSITU	7.40	2.10	13.28	PCI/GM	LASL77
2086	K40	1977	INSITU	10.53	7.19	15.01	PCI/GM	LASL77
2016	K40	1977	INSITU	7.24	2.33	30.94	PCI/GM	LASL77
2062	K40	1977	INSITU	9.83	5.10	16.90	PCI/GM	LASL77
2010	K40	1977	INSITU	6.79	1.71	18.10	PCI/GM	LASL77
2019	K40	1977	INSITU	6.69	2.24	16.11	PCI/GM	LASL77
2017	K40	1977	INSITU	7.25	2.33	26.60	PCI/GM	LASL77
2020	K40	1977	INSITU	3.17	3.48	19.48	PCI/GM	LASL77
2114	K40	1977	INSITU	10.46	7.18	14.48	PCI/GM	LASL77
2075	K40	1977	INSITU	10.85	4.60	14.80	PCI/GM	LASL77
2071	K40	1977	INSITU	9.83	4.48	16.20	PCI/GM	LASL77
2120	K40	1977	INSITU	14.30	7.16	19.70	PCI/GM	LASL77
2131	K40	1977	INSITU	6.62	1.87	19.80	PCI/GM	LASL77
2007	K40	1977	INSITU	7.10	2.07	17.43	PCI/GM	LASL77
2030	K40	1977	INSITU	10.39	4.30	18.60	PCI/GM	LASL77
2090	K40	1977	INSITU	13.85	7.69	29.60	PCI/GM	LASL77
2099	K40	1977	INSITU	11.12	10.93	10.60	PCI/GM	LASL77
1996	K40	1977	INSITU	6.45	.75	26.60	PCI/GM	LASL77
2013	K40	1977	INSITU	7.43	2.11	25.20	PCI/GM	LASL77
2022	K40	1977	INSITU	9.60	4.32	16.30	PCI/GM	LASL77
2126	K40	1977	INSITU	12.45	4.27	16.10	PCI/GM	LASL77
2014	K40	1977	INSITU	7.37	2.22	19.79	PCI/GM	LASL77
2041	K40	1977	INSITU	9.61	4.32	13.10	PCI/GM	LASL77
2042	K40	1977	INSITU	9.82	4.27	22.37	PCI/GM	LASL77
2080	K40	1977	INSITU	10.91	7.22	15.10	PCI/GM	LASL77
2136	K40	1977	INSITU	6.58	.55	12.55	PCI/GM	LASL77
2082	K40	1977	INSITU	11.62	7.18	18.80	PCI/GM	LASL77
2066	K40	1977	INSITU	10.60	4.42	20.80	PCI/GM	LASL77
2037	K40	1977	INSITU	9.82	4.27	21.90	PCI/GM	LASL77
2057	K40	1977	INSITU	10.35	5.34	17.80	PCI/GM	LASL77
2028	K40	1977	INSITU	10.37	4.33	18.90	PCI/GM	LASL77
1997	K40	1977	INSITU	6.46	1.16	12.84	PCI/GM	LASL77
2025	K40	1977	INSITU	10.12	4.27	12.81	PCI/GM	LASL77
2094	K40	1977	INSITU	14.49	9.25	18.10	PCI/GM	LASL77
2085	K40	1977	INSITU	12.60	6.58	15.30	PCI/GM	LASL77

2006	K40	1977	INSITU	7.07	2.04	4.66	PCI/GM LASL77
2093	K40	1977	INSITU	14.60	8.57	15.20	PCI/GM LASL77
2067	K40	1977	INSITU	9.31	4.96	14.80	PCI/GM LASL77
2053	K40	1977	INSITU	10.69	5.56	8.90	PCI/GM LASL77
2129	K40	1977	INSITU	6.27	0.00	21.66	PCI/GM LASL77
2122	K40	1977	INSITU	13.69	6.87	30.60	PCI/GM LASL77
2138	K40	1977	INSITU	5.81	2.17	25.31	PCI/GM LASL77
2015	K40	1977	INSITU	7.37	2.31	4.37	PCI/GM LASL77
2039	K40	1977	INSITU	9.60	4.32	12.10	PCI/GM LASL77
2049	K40	1977	INSITU	11.11	5.55	14.10	PCI/GM LASL77
2068	K40	1977	INSITU	9.30	5.02	18.20	PCI/GM LASL77
2097	K40	1977	INSITU	15.45	9.75	20.74	PCI/GM LASL77
2038	K40	1977	INSITU	9.60	4.32	11.20	PCI/GM LASL77
2081	K40	1977	INSITU	11.31	7.21	16.60	PCI/GM LASL77
2060	K40	1977	INSITU	9.91	5.07	23.90	PCI/GM LASL77
2079	K40	1977	INSITU	10.53	7.20	14.90	PCI/GM LASL77
2135	K40	1977	INSITU	6.58	.55	43.00	PCI/GM LASL77
2048	K40	1977	INSITU	11.09	5.87	14.50	PCI/GM LASL77
2033	K40	1977	INSITU	3.14	3.57	14.92	PCI/GM LASL77
2088	K40	1977	INSITU	13.22	7.66	16.40	PCI/GM LASL77
2031	K40	1977	INSITU	10.41	4.28	13.90	PCI/GM LASL77
2050	K40	1977	INSITU	11.11	5.55	13.60	PCI/GM LASL77
2143	K40	1977	INSITU	4.81	3.00	12.15	PCI/GM LASL77
2027	K40	1977	INSITU	10.28	4.20	9.65	PCI/GM LASL77
2141	K40	1977	INSITU	6.58	.55	26.40	PCI/GM LASL77
2059	K40	1977	INSITU	9.74	5.42	17.50	PCI/GM LASL77
2040	K40	1977	INSITU	9.60	4.32	11.32	PCI/GM LASL77
2139	K40	1977	INSITU	6.58	.55	24.90	PCI/GM LASL77
2132	K40	1977	INSITU	6.70	2.16	12.33	PCI/GM LASL77
2072	K40	1977	INSITU	9.86	4.42	21.10	PCI/GM LASL77
2074	K40	1977	INSITU	9.85	4.35	13.50	PCI/GM LASL77
2125	K40	1977	INSITU	14.68	4.45	28.90	PCI/GM LASL77
2024	K40	1977	INSITU	8.95	3.88	14.95	PCI/GM LASL77
2147	K40	1977	INSITU	7.77	3.07	12.60	PCI/GM LASL77
2087	K40	1977	INSITU	12.92	7.66	20.50	PCI/GM LASL77
2121	K40	1977	INSITU	13.68	6.87	28.90	PCI/GM LASL77
2092	K40	1977	INSITU	13.52	9.21	11.20	PCI/GM LASL77
2026	K40	1977	INSITU	10.05	4.07	19.50	PCI/GM LASL77
2100	K40	1977	INSITU	14.50	12.20	17.70	PCI/GM LASL77
2058	K40	1977	INSITU	10.00	5.31	19.50	PCI/GM LASL77
2095	K40	1977	INSITU	14.49	9.25	15.50	PCI/GM LASL77
2096	K40	1977	INSITU	14.49	9.24	15.90	PCI/GM LASL77
2142	K40	1977	INSITU	6.27	.00	22.40	PCI/GM LASL77
2012	K40	1977	INSITU	6.79	1.77	25.80	PCI/GM LASL77
2076	K40	1977	INSITU	11.09	4.52	7.40	PCI/GM LASL77
2052	K40	1977	INSITU	11.11	5.55	22.60	PCI/GM LASL77
2155	K40	1977	INSITU	3.91	3.49	13.50	PCI/GM LASL77
2148	K40	1977	INSITU	2.98	3.62	19.70	PCI/GM LASL77
2153	K40	1977	INSITU	3.94	4.88	7.25	PCI/GM LASL77
2096	NB95	1977	INSITU	14.49	9.24	5.06	NCI/M2 LASL77
2086	NB95	1977	INSITU	10.53	7.19	4.61	NCI/M2 LASL77
2123	NB95	1977	INSITU	13.68	6.79	0.00	NCI/M2 LASL77
2081	NB95	1977	INSITU	11.31	7.21	5.52	NCI/M2 LASL77
2097	NB95	1977	INSITU	15.45	9.75	3.79	NCI/M2 LASL77
2052	NB95	1977	INSITU	11.11	5.55	4.46	NCI/M2 LASL77
2122	NB95	1977	INSITU	13.69	6.87	2.96	NCI/M2 LASL77
2130	NB95	1977	INSITU	6.03	.60	1.66	NCI/M2 LASL77
2142	NB95	1977	INSITU	6.27	.00	2.01	NCI/M2 LASL77
2138	NB95	1977	INSITU	5.81	2.17	1.55	NCI/M2 LASL77
2118	NB95	1977	INSITU	14.55	6.45	5.46	NCI/M2 LASL77
2115	NB95	1977	INSITU	13.57	6.49	5.35	NCI/M2 LASL77
2129	NB95	1977	INSITU	6.27	0.00	2.88	NCI/M2 LASL77
1938	NB95	1977	INSITU	6.63	.55	3.55	NCI/M2 LASL77
2079	NB95	1977	INSITU	10.53	7.20	4.16	NCI/M2 LASL77
2135	NB95	1977	INSITU	6.58	.55	0.00	NCI/M2 LASL77
2141	NB95	1977	INSITU	6.58	.55	3.20	NCI/M2 LASL77
2030	NB95	1977	INSITU	10.39	4.30	5.19	NCI/M2 LASL77
2033	NB95	1977	INSITU	3.14	3.57	0.00	NCI/M2 LASL77
2058	NB95	1977	INSITU	10.00	5.31	4.59	NCI/M2 LASL77
2127	NB95	1977	INSITU	13.40	5.21	5.00	NCI/M2 LASL77
2090	NB95	1977	INSITU	13.85	7.69	4.77	NCI/M2 LASL77
2024	NB95	1977	INSITU	8.95	3.88	4.55	NCI/M2 LASL77
2148	NB95	1977	INSITU	2.98	3.62	2.59	NCI/M2 LASL77
2034	NB95	1977	INSITU	3.16	3.70	3.56	NCI/M2 LASL77
2032	NB95	1977	INSITU	3.17	3.48	2.82	NCI/M2 LASL77
2055	NB95	1977	INSITU	11.35	5.86	3.89	NCI/M2 LASL77
2087	NB95	1977	INSITU	12.92	7.66	4.57	NCI/M2 LASL77
2080	NB95	1977	INSITU	10.91	7.22	4.98	NCI/M2 LASL77
2016	NB95	1977	INSITU	7.24	2.33	3.66	NCI/M2 LASL77
2043	NB95	1977	INSITU	3.91	3.49	1.28	NCI/M2 LASL77

2121	NB95	1977	INSITU	13.68	6.87	6.39	NCI/M2	LASL77
2136	NB95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2023	NB95	1977	INSITU	9.54	3.98	5.48	NCI/M2	LASL77
2022	NB95	1977	INSITU	9.60	4.32	5.32	NCI/M2	LASL77
2088	NB95	1977	INSITU	13.22	7.66	0.00	NCI/M2	LASL77
2075	NB95	1977	INSITU	10.85	4.60	4.25	NCI/M2	LASL77
2125	NB95	1977	INSITU	14.68	4.45	5.52	NCI/M2	LASL77
2009	NB95	1977	INSITU	6.59	1.65	3.63	NCI/M2	LASL77
2154	NB95	1977	INSITU	3.95	4.57	2.01	NCI/M2	LASL77
1997	NB95	1977	INSITU	6.46	1.16	1.40	NCI/M2	LASL77
2064	NB95	1977	INSITU	10.54	7.19	4.37	NCI/M2	LASL77
2143	NB95	1977	INSITU	4.81	3.00	1.26	NCI/M2	LASL77
2057	NB95	1977	INSITU	10.35	5.34	5.71	NCI/M2	LASL77
2085	NB95	1977	INSITU	12.60	6.58	5.17	NCI/M2	LASL77
2076	NB95	1977	INSITU	11.09	4.52	4.38	NCI/M2	LASL77
2073	NB95	1977	INSITU	9.86	4.42	5.50	NCI/M2	LASL77
2041	NB95	1977	INSITU	9.61	4.32	4.02	NCI/M2	LASL77
2010	NB95	1977	INSITU	6.79	1.71	3.51	NCI/M2	LASL77
2012	NB95	1977	INSITU	6.79	1.77	4.46	NCI/M2	LASL77
2020	NB95	1977	INSITU	3.17	3.48	1.78	NCI/M2	LASL77
2047	NB95	1977	INSITU	11.08	5.74	4.16	NCI/M2	LASL77
2116	NB95	1977	INSITU	13.74	6.12	4.31	NCI/M2	LASL77
2072	NB95	1977	INSITU	9.86	4.42	5.37	NCI/M2	LASL77
2008	NB95	1977	INSITU	7.40	2.10	4.04	NCI/M2	LASL77
2099	NB95	1977	INSITU	11.12	10.93	4.37	NCI/M2	LASL77
2146	NB95	1977	INSITU	9.82	4.27	2.63	NCI/M2	LASL77
2014	NB95	1977	INSITU	7.37	2.22	3.00	NCI/M2	LASL77
2134	NB95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2031	NB95	1977	INSITU	10.41	4.28	6.63	NCI/M2	LASL77
2029	NB95	1977	INSITU	10.35	4.28	0.00	NCI/M2	LASL77
2026	NB95	1977	INSITU	10.05	4.07	5.03	NCI/M2	LASL77
2060	NB95	1977	INSITU	9.91	5.07	4.69	NCI/M2	LASL77
20[illegible]	NB95	1977	INSITU	9.85	4.35	4.66	NCI/M2	LASL77
2027	NB95	1977	INSITU	10.28	4.20	6.19	NCI/M2	LASL77
1996	NB95	1977	INSITU	6.45	.75	4.36	NCI/M2	LASL77
2140	NB95	1977	INSITU	6.58	.55	2.76	NCI/M2	LASL77
2094	NB95	1977	INSITU	14.49	9.25	4.82	NCI/M2	LASL77
2068	NB95	1977	INSITU	9.30	5.02	3.88	NCI/M2	LASL77
2037	NB95	1977	INSITU	9.82	4.27	5.13	NCI/M2	LASL77
2042	NB95	1977	INSITU	9.82	4.27	5.29	NCI/M2	LASL77
2147	NB95	1977	INSITU	7.77	3.07	1.65	NCI/M2	LASL77
2093	NB95	1977	INSITU	14.60	8.57	4.24	NCI/M2	LASL77
2019	NB95	1977	INSITU	6.69	2.24	3.81	NCI/M2	LASL77
2084	NB95	1977	INSITU	12.58	7.17	4.52	NCI/M2	LASL77
2013	NB95	1977	INSITU	7.43	2.11	0.00	NCI/M2	LASL77
2059	NB95	1977	INSITU	9.74	5.42	5.64	NCI/M2	LASL77
2067	NB95	1977	INSITU	9.31	4.96	3.27	NCI/M2	LASL77
2028	NB95	1977	INSITU	10.37	4.33	5.35	NCI/M2	LASL77
2132	NB95	1977	INSITU	6.70	2.16	1.83	NCI/M2	LASL77
2061	NB95	1977	INSITU	9.91	5.07	4.76	NCI/M2	LASL77
2017	NB95	1977	INSITU	7.25	2.33	4.10	NCI/M2	LASL77
2007	NB95	1977	INSITU	7.10	2.07	3.98	NCI/M2	LASL77
2119	NB95	1977	INSITU	14.34	7.21	4.43	NCI/M2	LASL77
2062	NB95	1977	INSITU	9.83	5.10	3.68	NCI/M2	LASL77
2155	NB95	1977	INSITU	3.91	3.49	2.18	NCI/M2	LASL77
2025	NB95	1977	INSITU	10.12	4.27	5.23	NCI/M2	LASL77
2039	NB95	1977	INSITU	9.60	4.32	4.19	NCI/M2	LASL77
2114	NB95	1977	INSITU	10.46	7.18	4.43	NCI/M2	LASL77
2126	NB95	1977	INSITU	12.45	4.27	4.77	NCI/M2	LASL77
2015	NB95	1977	INSITU	7.37	2.31	3.78	NCI/M2	LASL77
2092	NB95	1977	INSITU	13.52	9.21	4.51	NCI/M2	LASL77
2066	NB95	1977	INSITU	10.60	4.42	5.02	NCI/M2	LASL77
2077	NB95	1977	INSITU	10.31	4.41	4.29	NCI/M2	LASL77
2006	NB95	1977	INSITU	7.07	2.04	2.81	NCI/M2	LASL77
2131	NB95	1977	INSITU	6.62	1.87	2.14	NCI/M2	LASL77
2100	NB95	1977	INSITU	14.50	12.20	4.96	NCI/M2	LASL77
2120	NB95	1977	INSITU	14.30	7.16	5.75	NCI/M2	LASL77
2049	NB95	1977	INSITU	11.11	5.55	5.62	NCI/M2	LASL77
2038	NB95	1977	INSITU	9.60	4.32	4.57	NCI/M2	LASL77
2011	NB95	1977	INSITU	6.32	.00	4.65	NCI/M2	LASL77
2083	NB95	1977	INSITU	12.14	7.19	4.50	NCI/M2	LASL77
2128	NB95	1977	INSITU	13.77	5.47	3.82	NCI/M2	LASL77
2040	NB95	1977	INSITU	9.60	4.32	4.69	NCI/M2	LASL77
2082	NB95	1977	INSITU	11.62	7.18	5.35	NCI/M2	LASL77
2071	NB95	1977	INSITU	9.83	4.48	4.68	NCI/M2	LASL77
2053	NB95	1977	INSITU	10.69	5.56	5.25	NCI/M2	LASL77
2139	NB95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2153	NB95	1977	INSITU	3.94	4.88	1.76	NCI/M2	LASL77
2095	NB95	1977	INSITU	14.49	9.25	5.44	NCI/M2	LASL77
2144	NB95	1977	INSITU	10.46	7.19	2.19	NCI/M2	LASL77

2050	NB95	1977	INSITU		11.11	5.55	4.76	NCI/M2	LASL77
2048	NB95	1977	INSITU		11.09	5.87	4.10	NCI/M2	LASL77
2065	NB95	1977	INSITU		10.39	5.01	5.01	NCI/M2	LASL77
2018	NB95	1977	INSITU		6.66	1.76	4.03	NCI/M2	LASL77
2101	NB95	1977	INSITU		16.52	14.74	6.33	NCI/M2	LASL77
2003	PU238	1977	GR		6.63	.55	.00	PCI/GM	CVEG
2057	PU238	1977	GR		10.35	5.34	.00	PCI/GM	CVEG
2065	PU238	1977	GR		10.39	5.01	0.00	PCI/GM	CVEG
2001	PU238	1977	GR		6.63	.55	.01	PCI/GM	CVEG
1995	PU238	1977	GR		6.66	.76	0.00	PCI/GM	CVEG
2076	PU238	1977	JP		11.09	4.52	0.00	PCI/GM	CVEG
2059	PU238	1977	SK		9.74	5.42	0.00	PCI/GM	CVEG
2087	PU238	1977	SK		12.92	7.66	0.00	PCI/GM	CVEG
2048	PU238	1977	SK		11.09	5.87	0.00	PCI/GM	CVEG
2001	PU238	1977	SK		6.63	.55	0.00	PCI/GM	CVEG
2003	PU238	1977	SK		6.63	.55	0.00	PCI/GM	CVEG
2065	PU238	1977	SOIL	2.5	10.39	5.01	.01	PCI/GM	LASLCHEM
2009	PU238	1977	SOIL	7.5	6.59	1.65	.02	PCI/GM	LASLCHEM
2059	PU238	1977	SOIL	12.5	9.74	5.42	0.00	PCI/GM	LASLCHEM
2059	PU238	1977	SOIL	2.5	9.74	5.42	.06	PCI/GM	LASLCHEM
2047	PU238	1977	SOIL	7.5	11.08	5.74	.01	PCI/GM	LASLCHEM
2057	PU238	1977	SOIL	12.5	10.35	5.34	0.00	PCI/GM	LASLCHEM
2048	PU238	1977	SOIL	7.5	11.09	5.87	0.00	PCI/GM	LASLCHEM
2048	PU238	1977	SOIL	12.5	11.09	5.87	0.00	PCI/GM	LASLCHEM
2084	PU238	1977	SOIL	2.5	12.58	7.17	.06	PCI/GM	LASLCHEM
2014	PU238	1977	SOIL	7.5	7.37	2.22	.00	PCI/GM	LASLCHEM
2028	PU238	1977	SOIL	2.5	10.37	4.33	.20	PCI/GM	LASLCHEM
2072	PU238	1977	SOIL	12.5	9.86	4.42	.06	PCI/GM	LASLCHEM
2118	PU238	1977	SOIL	7.5	14.55	6.45	0.00	PCI/GM	LASLCHEM
2115	PU238	1977	SOIL	2.5	13.57	6.49	.01	PCI/GM	LASLCHEM
2119	PU238	1977	SOIL	7.5	14.34	7.21	0.00	PCI/GM	LASLCHEM
2121	PU238	1977	SOIL	2.5	13.68	6.87	.04	PCI/GM	LASLCHEM
2014	PU238	1977	SOIL	12.5	7.37	2.22	.01	PCI/GM	LASLCHEM
2118	PU238	1977	SOIL	2.5	14.55	6.45	.01	PCI/GM	LASLCHEM
2018	PU238	1977	SOIL	7.5	6.66	1.76	0.00	PCI/GM	LASLCHEM
2065	PU238	1977	SOIL	12.5	10.39	5.01	0.00	PCI/GM	LASLCHEM
2026	PU238	1977	SOIL	2.5	10.05	4.07	.17	PCI/GM	LASLCHEM
2084	PU238	1977	SOIL	12.5	12.58	7.17	0.00	PCI/GM	LASLCHEM
2014	PU238	1977	SOIL	2.5	7.37	2.22	.01	PCI/GM	LASLCHEM
2096	PU238	1977	SOIL	12.5	14.49	9.24	0.00	PCI/GM	LASLCHEM
2037	PU238	1977	SOIL	7.5	9.82	4.27	.08	PCI/GM	LASLCHEM
2003	PU238	1977	SOIL	2.5	6.63	.55	.07	PCI/GM	LASLCHEM
2009	PU238	1977	SOIL	2.5	6.59	1.65	.02	PCI/GM	LASLCHEM
2059	PU238	1977	SOIL	7.5	9.74	5.42	0.00	PCI/GM	LASLCHEM
2125	PU238	1977	SOIL	2.5	14.68	4.45	0.00	PCI/GM	LASLCHEM
2048	PU238	1977	SOIL	2.5	11.09	5.87	.02	PCI/GM	LASLCHEM
2115	PU238	1977	SOIL	7.5	13.57	6.49	0.00	PCI/GM	LASLCHEM
2060	PU238	1977	SOIL	17.5	9.91	5.07	.01	PCI/GM	LASLCHEM
2120	PU238	1977	SOIL	7.5	14.30	7.16	.03	PCI/GM	LASLCHEM
2003	PU238	1977	SOIL	7.5	6.63	.55	0.00	PCI/GM	LASLCHEM
2060	PU238	1977	SOIL	7.5	9.91	5.07	.02	PCI/GM	LASLCHEM
2082	PU238	1977	SOIL	2.5	11.62	7.18	.05	PCI/GM	LASLCHEM
2119	PU238	1977	SOIL	12.5	14.34	7.21	0.00	PCI/GM	LASLCHEM
2001	PU238	1977	SOIL	12.5	6.63	.55	0.00	PCI/GM	LASLCHEM
2076	PU238	1977	SOIL	2.5	11.09	4.52	.02	PCI/GM	LASLCHEM
2087	PU238	1977	SOIL	2.5	12.92	7.66	0.00	PCI/GM	LASLCHEM
2060	PU238	1977	SOIL	22.5	9.91	5.07	0.00	PCI/GM	LASLCHEM
2076	PU238	1977	SOIL	7.5	11.09	4.52	0.00	PCI/GM	LASLCHEM
2119	PU238	1977	SOIL	2.5	14.34	7.21	.01	PCI/GM	LASLCHEM
2049	PU238	1977	SOIL	12.5	11.11	5.55	0.00	PCI/GM	LASLCHEM
2052	PU238	1977	SOIL	17.5	11.11	5.55	0.00	PCI/GM	LASLCHEM
2049	PU238	1977	SOIL	2.5	11.11	5.55	.01	PCI/GM	LASLCHEM
2027	PU238	1977	SOIL	7.5	10.28	4.20	.01	PCI/GM	LASLCHEM
2060	PU238	1977	SOIL	12.5	9.91	5.07	.01	PCI/GM	LASLCHEM
2121	PU238	1977	SOIL	7.5	13.68	6.87	.03	PCI/GM	LASLCHEM
1995	PU238	1977	SOIL	12.5	6.66	.76	0.00	PCI/GM	LASLCHEM
2060	PU238	1977	SOIL	2.5	9.91	5.07	.05	PCI/GM	LASLCHEM
2073	PU238	1977	SOIL	2.5	9.86	4.42	.32	PCI/GM	LASLCHEM
1995	PU238	1977	SOIL	7.5	6.66	.76	0.00	PCI/GM	LASLCHEM
2016	PU238	1977	SOIL	12.5	7.24	2.33	.03	PCI/GM	LASLCHEM
2021	PU238	1977	SOIL	2.5	9.60	4.33	.11	PCI/GM	LASLCHEM
2128	PU238	1977	SOIL	2.5	13.77	5.47	.00	PCI/GM	LASLCHEM
2052	PU238	1977	SOIL	7.5	11.11	5.55	0.00	PCI/GM	LASLCHEM
2080	PU238	1977	SOIL	2.5	10.91	7.22	0.00	PCI/GM	LASLCHEM
2001	PU238	1977	SOIL	2.5	6.63	.55	3.09	PCI/GM	LASLCHEM
2003	PU238	1977	SOIL	12.5	6.63	.55	0.00	PCI/GM	LASLCHEM
2057	PU238	1977	SOIL	7.5	10.35	5.34	.02	PCI/GM	LASLCHEM
2096	PU238	1977	SOIL	7.5	14.49	9.24	0.00	PCI/GM	LASLCHEM
2018	PU238	1977	SOIL	2.5	6.66	1.76	.67	PCI/GM	LASLCHEM
2026	PU238	1977	SOIL	7.5	10.05	4.07	.01	PCI/GM	LASLCHEM

1995	PU238	1977	SOIL	2.5	6.66	.76	0.00	PCI/GM	LASLCHEM
2018	PU238	1977	SOIL	12.5	6.66	1.76	0.00	PCI/GM	LASLCHEM
2123	PU238	1977	SOIL	2.5	13.68	6.79	.02	PCI/GM	LASLCHEM
2097	PU238	1977	SOIL	7.5	15.45	9.75	.00	PCI/GM	LASLCHEM
2072	PU238	1977	SOIL	7.5	9.86	4.42	.19	PCI/GM	LASLCHEM
2115	PU238	1977	SOIL	12.5	13.37	6.49	0.00	PCI/GM	LASLCHEM
2097	PU238	1977	SOIL	12.5	15.45	9.75	0.00	PCI/GM	LASLCHEM
2057	PU238	1977	SOIL	2.5	10.35	5.34	.03	PCI/GM	LASLCHEM
2052	PU238	1977	SOIL	2.5	11.11	5.55	.00	PCI/GM	LASLCHEM
2082	PU238	1977	SOIL	12.5	11.62	7.18	0.00	PCI/GM	LASLCHEM
2088	PU238	1977	SOIL	2.5	13.22	7.66	.03	PCI/GM	LASLCHEM
2071	PU238	1977	SOIL	2.5	9.83	4.48	.08	PCI/GM	LASLCHEM
2047	PU238	1977	SOIL	17.5	11.08	5.74	0.00	PCI/GM	LASLCHEM
1998	PU238	1977	SOIL	12.5	6.63	.55	0.00	PCI/GM	LASLCHEM
2052	PU238	1977	SOIL	12.5	11.11	5.55	.01	PCI/GM	LASLCHEM
2071	PU238	1977	SOIL	12.5	9.83	4.48	0.00	PCI/GM	LASLCHEM
2026	PU238	1977	SOIL	12.5	10.05	4.07	0.00	PCI/GM	LASLCHEM
2072	PU238	1977	SOIL	2.5	9.86	4.42	.22	PCI/GM	LASLCHEM
2028	PU238	1977	SOIL	7.5	10.37	4.33	.01	PCI/GM	LASLCHEM
2016	PU238	1977	SOIL	2.5	7.24	2.33	.00	PCI/GM	LASLCHEM
1998	PU238	1977	SOIL	7.5	6.63	.55	3.00	PCI/GM	LASLCHEM
2001	PU238	1977	SOIL	7.5	6.63	.55	2.29	PCI/GM	LASLCHEM
2097	PU238	1977	SOIL	2.5	15.45	9.75	.02	PCI/GM	LASLCHEM
2047	PU238	1977	SOIL	12.5	11.08	5.74	.01	PCI/GM	LASLCHEM
2082	PU238	1977	SOIL	7.5	11.62	7.18	0.00	PCI/GM	LASLCHEM
1998	PU238	1977	SOIL	2.5	6.63	.55	1.26	PCI/GM	LASLCHEM
2065	PU238	1977	SOIL	7.5	10.39	5.01	0.00	PCI/GM	LASLCHEM
2080	PU238	1977	SOIL	7.5	10.91	7.22	0.00	PCI/GM	LASLCHEM
2037	PU238	1977	SOIL	2.5	9.82	4.27	.10	PCI/GM	LASLCHEM
2080	PU238	1977	SOIL	12.5	10.91	7.22	0.00	PCI/GM	LASLCHEM
2047	PU238	1977	SOIL	2.5	11.08	5.74	.04	PCI/GM	LASLCHEM
2027	PU238	1977	SOIL	12.5	10.28	4.20	0.00	PCI/GM	LASLCHEM
2084	PU238	1977	SOIL	7.5	12.58	7.17	0.00	PCI/GM	LASLCHEM
2027	PU238	1977	SOIL	2.5	10.28	4.20	.09	PCI/GM	LASLCHEM
2028	PU238	1977	SOIL	12.5	10.37	4.33	0.00	PCI/GM	LASLCHEM
2118	PU238	1977	SOIL	12.5	14.55	6.45	0.00	PCI/GM	LASLCHEM
2009	PU238	1977	SOIL	12.5	6.59	1.65	.02	PCI/GM	LASLCHEM
2096	PU238	1977	SOIL	2.5	14.49	9.24	.01	PCI/GM	LASLCHEM
2028	PU238	1977	TH		10.37	4.33	0.00	PCI/GM	CVEG
2001	PU239	1977	GR		6.63	.55	.02	PCI/GM	CVEG
2065	PU239	1977	GR		10.39	5.01	.07	PCI/GM	CVEG
2057	PU239	1977	GR		10.35	5.34	.01	PCI/GM	CVEG
2003	PU239	1977	GR		6.63	.55	.02	PCI/GM	CVEG
1995	PU239	1977	GR		6.66	.76	.00	PCI/GM	CVEG
2045	PU239	1977	INSITU		10.52	5.51	2.60	NCI/M2	PREDICTED
2047	PU239	1977	INSITU		11.08	5.74	53.70	NCI/M2	PREDICTED
2046	PU239	1977	INSITU		11.08	5.73	55.30	NCI/M2	PREDICTED
2053	PU239	1977	INSITU		10.69	5.56	121.60	NCI/M2	PREDICTED
2064	PU239	1977	INSITU		10.54	7.19	2.30	NCI/M2	PREDICTED
2068	PU239	1977	INSITU		9.30	5.02	62.00	NCI/M2	PREDICTED
2127	PU239	1977	INSITU		13.40	5.21	.29	NCI/M2	PREDICTED
2024	PU239	1977	INSITU		8.95	3.88	25.70	NCI/M2	PREDICTED
2101	PU239	1977	INSITU		16.52	14.74	2.00	NCI/M2	PREDICTED
2050	PU239	1977	INSITU		11.11	5.55	20.50	NCI/M2	PREDICTED
2072	PU239	1977	INSITU		9.86	4.42	470.50	NCI/M2	PREDICTED
2021	PU239	1977	INSITU		9.60	4.33	351.80	NCI/M2	PREDICTED
2123	PU239	1977	INSITU		13.68	6.79	16.80	NCI/M2	PREDICTED
2054	PU239	1977	INSITU		10.52	5.50	1.20	NCI/M2	PREDICTED
2055	PU239	1977	INSITU		11.35	5.86	1.40	NCI/M2	PREDICTED
2040	PU239	1977	INSITU		9.60	4.32	141.20	NCI/M2	PREDICTED
2120	PU239	1977	INSITU		14.30	7.16	27.90	NCI/M2	PREDICTED
2091	PU239	1977	INSITU		15.00	7.64	14.10	NCI/M2	PREDICTED
2092	PU239	1977	INSITU		13.52	9.21	5.40	NCI/M2	PREDICTED
2026	PU239	1977	INSITU		10.05	4.07	374.60	NCI/M2	PREDICTED
2075	PU239	1977	INSITU		10.85	4.60	1.40	NCI/M2	PREDICTED
2062	PU239	1977	INSITU		9.83	5.10	72.60	NCI/M2	PREDICTED
2066	PU239	1977	INSITU		10.60	4.42	60.50	NCI/M2	PREDICTED
2099	PU239	1977	INSITU		11.12	10.93	4.50	NCI/M2	PREDICTED
2093	PU239	1977	INSITU		14.60	8.57	24.20	NCI/M2	PREDICTED
2095	PU239	1977	INSITU		14.49	9.25	4.90	NCI/M2	PREDICTED
2122	PU239	1977	INSITU		13.69	6.87	27.30	NCI/M2	PREDICTED
2076	PU239	1977	INSITU		11.09	4.52	30.10	NCI/M2	PREDICTED
2023	PU239	1977	INSITU		9.54	3.98	142.50	NCI/M2	PREDICTED
2022	PU239	1977	INSITU		9.60	4.32	261.20	NCI/M2	PREDICTED
2074	PU239	1977	INSITU		9.85	4.35	63.90	NCI/M2	PREDICTED
2090	PU239	1977	INSITU		13.85	7.69	19.30	NCI/M2	PREDICTED
2084	PU239	1977	INSITU		12.58	7.17	27.00	NCI/M2	PREDICTED
2085	PU239	1977	INSITU		12.60	6.58	33.20	NCI/M2	PREDICTED
2125	PU239	1977	INSITU		14.68	4.45	16.70	NCI/M2	PREDICTED
2037	PU239	1977	INSITU		9.82	4.27	398.70	NCI/M2	PREDICTED

2058	PU239	1977	INSITU		10.00	5.31	12[illegible].20	NCI/M2	PREDICTED
2025	PU239	1977	INSITU		10.12	4.27	43[illegible].90	NCI/M2	PREDICTED
2032	PU239	1977	INSITU		3.17	3.48	11.20	NCI/M2	PREDICTED
2031	PU239	1977	INSITU		10.41	4.28	101.50	NCI/M2	PREDICTED
2087	PU239	1977	INSITU		12.92	7.66	58.20	NCI/M2	PREDICTED
2059	PU239	1977	INSITU		9.74	5.42	56.90	NCI/M2	PREDICTED
2052	PU239	1977	INSITU		11.11	5.55	18.80	NCI/M2	PREDICTED
2073	PU239	1977	INSITU		9.86	4.42	4.60	NCI/M2	PREDICTED
2049	PU239	1977	INSITU		11.11	5.55	24.60	NCI/M2	PREDICTED
2086	PU239	1977	INSITU		10.53	7.19	5.10	NCI/M2	PREDICTED
2118	PU239	1977	INSITU		14.55	6.45	16.60	NCI/M2	PREDICTED
2088	PU239	1977	INSITU		13.22	7.66	48.90	NCI/M2	PREDICTED
2128	PU239	1977	INSITU		13.77	5.47	1.60	NCI/M2	PREDICTED
2082	PU239	1977	INSITU		11.62	7.18	37.70	NCI/M2	PREDICTED
2083	PU239	1977	INSITU		12.14	7.19	65.00	NCI/M2	PREDICTED
2097	PU239	1977	INSITU		15.45	9.75	21.70	NCI/M2	PREDICTED
2080	PU239	1977	INSITU		10.91	7.22	8.20	NCI/M2	PREDICTED
2067	PU239	1977	INSITU		9.31	4.96	19.10	NCI/M2	PREDICTED
2089	PU239	1977	INSITU		14.03	8.82	36.20	NCI/M2	PREDICTED
2048	PU239	1977	INSITU		11.09	5.87	41.20	NCI/M2	PREDICTED
2028	PU239	1977	INSITU		10.37	4.33	504.90	NCI/M2	PREDICTED
2039	PU239	1977	INSITU		9.60	4.32	256.90	NCI/M2	PREDICTED
2027	PU239	1977	INSITU		10.26	4.20	155.00	NCI/M2	PREDICTED
2121	PU239	1977	INSITU		13.68	6.87	17.90	NCI/M2	PREDICTED
2115	PU239	1977	INSITU		13.57	6.49	13.10	NCI/M2	PREDICTED
2071	PU239	1977	INSITU		9.83	4.48	177.20	NCI/M2	PREDICTED
2094	PU239	1977	INSITU		14.49	9.25	15.70	NCI/M2	PREDICTED
2060	PU239	1977	INSITU		9.91	5.07	122.20	NCI/M2	PREDICTED
2079	PU239	1977	INSITU		10.53	7.20	5.80	NCI/M2	PREDICTED
2038	PU239	1977	INSITU		9.60	4.32	170.80	NCI/M2	PREDICTED
2029	PU239	1977	INSITU		10.35	4.28	8.10	NCI/M2	PREDICTED
2114	PU239	1977	INSITU		10.46	7.18	4.50	NCI/M2	PREDICTED
2057	PU239	1977	INSITU		10.35	5.34	49.30	NCI/M2	PREDICTED
2100	PU239	1977	INSITU		14.50	12.20	4.20	NCI/M2	PREDICTED
2065	PU239	1977	INSITU		10.39	5.01	94.80	NCI/M2	PREDICTED
2077	PU239	1977	INSITU		10.31	4.41	1.20	NCI/M2	PREDICTED
2042	PU239	1977	INSITU		9.82	4.27	352.10	NCI/M2	PREDICTED
2126	PU239	1977	INSITU		12.45	4.27	7.40	NCI/M2	PREDICTED
2030	PU239	1977	INSITU		10.39	4.30	437.90	NCI/M2	PREDICTED
2119	PU239	1977	INSITU		14.34	7.21	9.10	NCI/M2	PREDICTED
2041	PU239	1977	INSITU		9.61	4.32	255.00	NCI/M2	PREDICTED
2061	PU239	1977	INSITU		9.91	5.07	22.50	NCI/M2	PREDICTED
2051	PU239	1977	INSITU		11.11	5.55	267.10	NCI/M2	PREDICTED
2081	PU239	1977	INSITU		11.31	7.21	27.60	NCI/M2	PREDICTED
2096	PU239	1977	INSITU		14.49	9.24	15.10	NCI/M2	PREDICTED
2116	PU239	1977	INSITU		13.74	6.12	10.90	NCI/M2	PREDICTED
2076	PU239	1977	JP		11.09	4.52	.01	PCI/GM	CVEG
2087	PU239	1977	SK		12.92	7.66	.02	PCI/GM	CVEG
2001	PU239	1977	SK		6.63	.55	0.00	PCI/GM	CVEG
2003	PU239	1977	SK		6.63	.55	.01	PCI/GM	CVEG
2048	PU239	1977	SK		11.09	5.87	.01	PCI/GM	CVEG
2059	PU239	1977	SK		9.74	5.42	.04	PCI/GM	CVEG
518	PU239	1973	SOIL	2.5	7.19	2.24	10.00	NCI/M2	EPA
534	PU239	1977	SOIL	2.5	24.04	15.09	2.20	NCI/M2	EPA
2057	PU239	1977	SOIL	12.5	10.35	5.34	.01	PCI/GM	LASLCHEM
524	PU239	1973	SOIL	2.5	7.76	2.96	8.50	NCI/M2	EPA
560	PU239	1973	SOIL	2.5	15.04	7.62	40.00	NCI/M2	EPA
525	PU239	1973	SOIL	2.5	8.25	2.94	2.00	NCI/M2	EPA
3002	PU239	1977	SOIL	7.5	3.91	3.49	.01	PCI/GM	LASLCHEM
1995	PU239	1977	SOIL	12.5	6.66	.76	0.00	PCI/GM	LASLCHEM
522	PU239	1973	SOIL	2.5	6.82	2.87	2.90	NCI/M2	EPA
582	PU239	1977	SOIL	2.5	21.85	15.46	.80	NCI/M2	EPA
581	PU239	1977	SOIL	2.5	20.63	15.53	1.80	NCI/M2	EPA
203	PU239	1972	SOIL	5.0	7.81	1.89	.33	PCI/GM	LASL72
515	PU239	1973	SOIL	2.5	10.82	1.34	.79	NCI/M2	EPA
564	PU239	1977	SOIL	2.5	15.03	9.53	.82	NCI/M2	EPA
2082	PU239	1977	SOIL	12.5	11.62	7.18	0.00	PCI/GM	LASLCHEM
108	PU239	1948	SOIL	1.3	9.98	4.31	9.50	PCI/GM	UCLA48
520	PU239	1973	SOIL	2.5	5.72	3.04	.93	NCI/M2	EPA
580	PU239	1977	SOIL	2.5	19.82	15.59	1.80	NCI/M2	EPA
567	PU239	1977	SOIL	2.5	12.66	11.54	.56	NCI/M2	EPA
3004	PU239	1977	SOIL	12.5	3.91	3.49	0.00	PCI/GM	LASLCHEM
507	PU239	1973	SOIL	2.5	3.57	1.92	1.80	NCI/M2	EPA
107	PU239	1948	SOIL	1.3	9.49	3.78	4.10	PCI/GM	UCLA48
14	PU239	1950	SOIL	1.3	14.27	5.80	0.00	PCI/GM	UCLA50
3004	PU239	1977	SOIL	7.5	3.91	3.49	0.00	PCI/GM	LASLCHEM
517	PU239	1973	SOIL	2.5	7.45	2.21	12.00	NCI/M2	EPA
501	PU239	1973	SOIL	2.5	6.57	.71	1100.00	NCI/M2	EPA
545	PU239	1973	SOIL	2.5	10.30	5.36	42.10	NCI/M2	EPA
2125	PU239	1977	SOIL	2.5	14.68	4.45	.03	PCI/GM	LASLCHEM

583	PU239	1977	SOIL	2.5	23.14	15.37	3.80	NCI/M2	EPA
536	PU239	1973	SOIL	2.5	11.31	4.39	4.90	NCI/M2	EPA
200	PU239	1972	SOIL	1.3	6.64	.55	255.00	PCI/GM	LASL72
208	PU239	1972	SOIL	5.0	10.80	5.26	.09	PCI/GM	LASL72
566	PU239	1977	SOIL	2.5	12.06	11.12	.42	NCI/M2	EPA
556	PU239	1973	SOIL	2.5	12.67	7.19	45.00	NCI/M2	EPA
112	PU239	1948	SOIL	1.3	9.74	4.84	.40	PCI/GM	UCLA48
555	PU239	1973	SOIL	2.5	11.49	6.59	4.10	NCI/M2	EPA
550	PU239	1973	SOIL	2.5	10.40	5.84	32.00	NCI/M2	EPA
528	PU239	1973	SOIL	2.5	8.46	3.83	2.60	NCI/M2	EPA
2026	PU239	1977	SOIL	2.5	10.05	4.07	3.51	PCI/GM	LASLCHEM
1	PU239	1950	SOIL	1.3	10.24	4.22	5.40	PCI/GM	UCLA50
557	PU239	1973	SOIL	2.5	15.57	6.87	18.00	NCI/M2	EPA
548	PU239	1973	SOIL	2.5	9.68	5.42	3.60	NCI/M2	EPA
562	PU239	1977	SOIL	2.5	14.27	9.56	2.50	NCI/M2	EPA
2048	PU239	1977	SOIL	7.5	11.09	5.87	.02	PCI/GM	LASLCHEM
519	PU239	1973	SOIL	2.5	5.22	3.09	.61	NCI/M2	EPA
565	PU239	1977	SOIL	2.5	14.01	10.96	2.90	NCI/M2	EPA
203	PU239	1972	SOIL	19.0	7.81	1.89	.21	PCI/GM	LASL72
2120	PU239	1977	SOIL	12.5	14.30	7.16	.04	PCI/GM	LASLCHEM
576	PU239	1977	SOIL	2.5	18.39	10.76	9.10	NCI/M2	EPA
540	PU239	1973	SOIL	2.5	10.38	4.94	68.00	NCI/M2	EPA
506	PU239	1973	SOIL	2.5	6.15	1.99	1.10	NCI/M2	EPA
15	PU239	1950	SOIL	1.3	13.67	7.12	.09	PCI/GM	UCLA50
513	PU239	1973	SOIL	2.5	9.44	2.00	.63	NCI/M2	EPA
2060	PU239	1977	SOIL	2.5	9.91	5.07	1.06	PCI/GM	LASLCHEM
116	PU239	1948	SOIL	1.3	11.87	5.11	.77	PCI/GM	UCLA48
511	PU239	1973	SOIL	2.5	8.93	2.19	1.50	NCI/M2	EPA
570	PU239	1977	SOIL	2.5	15.05	12.09	4.60	NCI/M2	EPA
533	PU239	1973	SOIL	2.5	10.82	3.59	1.00	NCI/M2	EPA
512	PU239	1973	SOIL	2.5	9.80	1.68	.71	NCI/M2	EPA
2052	PU239	1977	SOIL	12.5	11.11	5.55	.01	PCI/GM	LASLCHEM
578	PU239	1977	SOIL	2.5	17.82	15.76	2.10	NCI/M2	EPA
514	PU239	1973	SOIL	2.5	10.27	1.49	.84	NCI/M2	EPA
207	PU239	1972	SOIL	5.0	10.22	4.59	.02	PCI/GM	LASL72
2018	PU239	1977	SOIL	12.5	6.66	1.76	.00	PCI/GM	LASLCHEM
552	PU239	1973	SOIL	2.5	11.50	5.74	40.00	NCI/M2	EPA
579	PU239	1977	SOIL	2.5	18.95	15.67	2.90	NCI/M2	EPA
13	PU239	1950	SOIL	1.3	12.59	7.17	.54	PCI/GM	UCLA50
12	PU239	1950	SOIL	1.3	13.20	6.36	4.10	PCI/GM	UCLA50
534	PU239	1973	SOIL	2.5	10.38	4.45	6.10	NCI/M2	EPA
2097	PU239	1977	SOIL	2.5	15.45	9.75	.61	PCI/GM	LASLCHEM
5	PU239	1950	SOIL	1.3	10.72	5.90	2.70	PCI/GM	UCLA50
2027	PU239	1977	SOIL	7.5	10.28	4.20	.20	PCI/GM	LASLCHEM
546	PU239	1973	SOIL	2.5	8.79	5.68	2.40	NCI/M2	EPA
544	PU239	1973	SOIL	2.5	10.29	5.37	86.00	NCI/M2	EPA
553	PU239	1973	SOIL	2.5	11.66	5.05	29.00	NCI/M2	EPA
2096	PU239	1977	SOIL	2.5	14.49	9.24	.21	PCI/GM	LASLCHEM
530	PU239	1973	SOIL	2.5	9.34	4.12	52.00	NCI/M2	EPA
1995	PU239	1977	SOIL	7.5	6.66	.76	0.00	PCI/GM	LASLCHEM
2009	PU239	1977	SOIL	2.5	6.59	1.65	.48	PCI/GM	LASLCHEM
543	PU239	1973	SOIL	2.5	10.30	5.37	8.00	NCI/M2	EPA
541	PU239	1973	SOIL	2.5	10.90	4.88	28.00	NCI/M2	EPA
532	PU239	1973	SOIL	2.5	10.43	4.16	.40	NCI/M2	EPA
102	PU239	1948	SOIL	1.3	7.69	1.76	2.50	PCI/GM	UCLA48
2118	PU239	1977	SOIL	7.5	14.55	6.45	.01	PCI/GM	LASLCHEM
551	PU239	1973	SOIL	2.5	11.09	5.83	17.00	NCI/M2	EPA
2026	PU239	1977	SOIL	12.5	10.05	4.07	.02	PCI/GM	LASLCHEM
2096	PU239	1977	SOIL	12.5	14.49	9.24	0.00	PCI/GM	LASLCHEM
2121	PU239	1977	SOIL	7.5	13.68	6.87	.51	PCI/GM	LASLCHEM
558	PU239	1973	SOIL	2.5	16.02	6.31	.98	NCI/M2	EPA
529	PU239	1973	SOIL	2.5	8.95	3.94	3.00	NCI/M2	EPA
11	PU239	1950	SOIL	1.3	13.43	5.88	.72	PCI/GM	UCLA50
2009	PU239	1977	SOIL	12.5	6.59	1.65	.47	PCI/GM	LASLCHEM
537	PU239	1973	SOIL	2.5	11.41	4.01	1.50	NCI/M2	EPA
503	PU239	1973	SOIL	2.5	7.42	1.23	1.70	NCI/M2	EPA
2052	PU239	1977	SOIL	17.5	11.11	5.55	.00	PCI/GM	LASLCHEM
505	PU239	1973	SOIL	2.5	6.70	1.45	110.00	NCI/M2	EPA
521	PU239	1973	SOIL	2.5	6.27	3.00	.56	NCI/M2	EPA
559	PU239	1973	SOIL	2.5	10.65	7.21	8.60	NCI/M2	EPA
2048	PU239	1977	SOIL	12.5	11.09	5.87	.01	PCI/GM	LASLCHEM
568	PU239	1977	SOIL	2.5	13.34	12.05	1.90	NCI/M2	EPA
16	PU239	1950	SOIL	1.3	14.49	6.57	.77	PCI/GM	UCLA50
110	PU239	1948	SOIL	1.3	11.49	4.59	.20	PCI/GM	UCLA48
2060	PU239	1977	SOIL	12.5	9.91	5.07	.16	PCI/GM	LASLCHEM
2052	PU239	1977	SOIL	2.5	11.11	5.55	.12	PCI/GM	LASLCHEM
2016	PU239	1977	SOIL	2.5	7.24	2.33	.12	PCI/GM	LASLCHEM
527	PU239	1973	SOIL	2.5	8.82	3.45	48.00	NCI/M2	EPA
8	PU239	1950	SOIL	1.3	11.07	6.63	1.30	PCI/GM	UCLA50
3003	PU239	1977	SOIL	7.5	3.91	3.49	0.00	PCI/GM	LASLCHEM

2	PU239	1950	SOIL	1.3	10.36	4.68	11.00	PCI/GM	UCLA50
2003	PU239	1977	SOIL	2.5	6.63	.55	3.80	PCI/GM	LASLCHEM
2120	PU239	1977	SOIL	7.5	14.30	7.16	.60	PCI/GM	LASLCHEM
111	PU239	1948	SOIL	1.3	10.44	4.84	10.80	PCI/GM	UCLA48
3	PU239	1950	SOIL	1.3	10.34	5.01	5.90	PCI/GM	UCLA50
523	PU239	1973	SOIL	2.5	7.25	2.92	1.80	NCI/M2	EPA
206	PU239	1972	SOIL	5.0	9.59	3.89	.34	PCI/GM	LASL72
575	PU239	1977	SOIL	2.5	18.33	10.92	.91	NCI/M2	EPA
4	PU239	1950	SOIL	1.3	11.19	4.60	2.00	PCI/GM	UCLA50
569	PU239	1977	SOIL	2.5	14.14	12.17	1.10	NCI/M2	EPA
2097	PU239	1977	SOIL	12.5	15.45	9.75	.01	PCI/GM	LASLCHEM
113	PU239	1948	SOIL	1.3	11.70	4.85	0.00	PCI/GM	UCLA48
201	PU239	1972	SOIL	1.3	6.64	.55	.04	PCI/GM	LASL72
2080	PU239	1977	SOIL	2.5	10.91	7.22	.03	PCI/GM	LASLCHEM
200	PU239	1972	SOIL	19.0	6.64	.55	61.90	PCI/GM	LASL72
2049	PU239	1977	SOIL	12.5	11.11	5.55	0.00	PCI/GM	LASLCHEM
205	PU239	1972	SOIL	5.0	9.03	3.26	.12	PCI/GM	LASL72
2027	PU239	1977	SOIL	2.5	10.28	4.20	1.71	PCI/GM	LASLCHEM
201	PU239	1972	SOIL	19.0	6.64	.55	.02	PCI/GM	LASL72
509	PU239	1973	SOIL	2.5	7.36	1.85	25.00	NCI/M2	EPA
531	PU239	1973	SOIL	2.5	9.95	4.16	47.00	NCI/M2	EPA
3001	PU239	1977	SOIL	2.5	3.91	3.49	.00	PCI/GM	LASLCHEM
508	PU239	1973	SOIL	2.5	6.65	2.07	1.20	NCI/M2	EPA
2115	PU239	1977	SOIL	7.5	13.57	6.49	.02	PCI/GM	LASLCHEM
577	PU239	1977	SOIL	2.5	16.88	15.86	1.30	NCI/M2	EPA
2072	PU239	1977	SOIL	12.5	9.86	4.42	1.15	PCI/GM	LASLCHEM
200	PU239	1972	SOIL	5.0	6.64	.55	263.00	PCI/GM	LASL72
202	PU239	1972	SOIL	19.0	7.23	1.23	.01	PCI/GM	LASL72
1995	PU239	1977	SOIL	2.5	6.66	.76	0.00	PCI/GM	LASLCHEM
2047	PU239	1977	SOIL	2.5	11.08	5.74	.98	PCI/GM	LASLCHEM
2126	PU239	1977	SOIL	2.5	12.45	4.27	.01	PCI/GM	LASLCHEM
554	PU239	1973	SOIL	2.5	10.63	7.12	20.00	NCI/M2	EPA
573	PU239	1977	SOIL	2.5	16.90	11.61	.32	NCI/M2	EPA
206	PU239	1972	SOIL	19.0	9.59	3.89	.06	PCI/GM	LASL72
2060	PU239	1977	SOIL	17.5	9.91	5.07	.09	PCI/GM	LASLCHEM
2003	PU239	1977	SOIL	7.5	6.63	.55	.05	PCI/GM	LASLCHEM
500	PU239	1973	SOIL	2.5	6.59	.45	1.10	NCI/M2	EPA
572	PU239	1977	SOIL	2.5	16.48	12.49	2.00	NCI/M2	EPA
2096	PU239	1977	SOIL	7.5	14.49	9.24	0.00	PCI/GM	LASLCHEM
561	PU239	1977	SOIL	2.5	13.41	10.16	21.00	NCI/M2	EPA
563	PU239	1977	SOIL	2.5	14.61	8.97	4.70	NCI/M2	EPA
204	PU239	1972	SOIL	5.0	6.64	.55	.04	PCI/GM	LASL72
2065	PU239	1977	SOIL	7.5	10.39	5.01	.00	PCI/GM	LASLCHEM
547	PU239	1973	SOIL	2.5	9.24	5.75	1.90	NCI/M2	EPA
2014	PU239	1977	SOIL	7.5	7.37	2.22	.71	PCI/GM	LASLCHEM
2076	PU239	1977	SOIL	12.5	11.09	4.52	.02	PCI/GM	LASLCHEM
2071	PU239	1977	SOIL	2.5	9.83	4.48	1.54	PCI/GM	LASLCHEM
103	PU239	1948	SOIL	1.3	8.06	2.17	1.60	PCI/GM	UCLA48
504	PU239	1973	SOIL	2.5	6.95	1.34	27.00	NCI/M2	EPA
207	PU239	1972	SOIL	19.0	10.22	4.59	.01	PCI/GM	LASL72
2065	PU239	1977	SOIL	2.5	10.39	5.01	.27	PCI/GM	LASLCHEM
2001	PU239	1977	SOIL	12.5	6.63	.55	201.00	PCI/GM	LASLCHEM
571	PU239	1977	SOIL	2.5	15.86	12.01	.76	NCI/M2	EPA
2047	PU239	1977	SOIL	12.5	11.08	5.74	.17	PCI/GM	LASLCHEM
3002	PU239	1977	SOIL	2.5	3.91	3.49	.01	PCI/GM	LASLCHEM
3004	PU239	1977	SOIL	2.5	3.91	3.49	.02	PCI/GM	LASLCHEM
2118	PU239	1977	SOIL	2.5	14.55	6.45	.18	PCI/GM	LASLCHEM
2014	PU239	1977	SOIL	2.5	7.37	2.22	.17	PCI/GM	LASLCHEM
2073	PU239	1977	SOIL	2.5	9.86	4.42	6.70	PCI/GM	LASLCHEM
2052	PU239	1977	SOIL	27.5	11.11	5.55	0.00	PCI/GM	LASLCHEM
10	PU239	1950	SOIL	1.3	12.84	6.60	.40	PCI/GM	UCLA50
2121	PU239	1977	SOIL	2.5	13.68	6.87	.69	PCI/GM	LASLCHEM
2059	PU239	1977	SOIL	7.5	9.74	5.42	.03	PCI/GM	LASLCHEM
2080	PU239	1977	SOIL	12.5	10.91	7.22	.02	PCI/GM	LASLCHEM
2047	PU239	1977	SOIL	7.5	11.08	5.74	.24	PCI/GM	LASLCHEM
3002	PU239	1977	SOIL	12.5	3.91	3.49	0.00	PCI/GM	LASLCHEM
2059	PU239	1977	SOIL	12.5	9.74	5.42	.02	PCI/GM	LASLCHEM
3003	PU239	1977	SOIL	12.5	3.91	3.49	0.00	PCI/GM	LASLCHEM
538	PU239	1973	SOIL	2.5	11.41	3.79	4.10	NCI/M2	EPA
2123	PU239	1977	SOIL	2.5	13.68	6.79	.55	PCI/GM	LASLCHEM
2119	PU239	1977	SOIL	7.5	14.34	7.21	0.00	PCI/GM	LASLCHEM
2052	PU239	1977	SOIL	32.5	11.11	5.55	.00	PCI/GM	LASLCHEM
549	PU239	1973	SOIL	2.5	11.08	5.40	36.00	NCI/M2	EPA
2028	PU239	1977	SOIL	12.5	10.37	4.33	.01	PCI/GM	LASLCHEM
1998	PU239	1977	SOIL	2.5	6.63	.55	24.30	PCI/GM	LASLCHEM
3001	PU239	1977	SOIL	12.5	3.91	3.49	0.00	PCI/GM	LASLCHEM
2119	PU239	1977	SOIL	2.5	14.34	7.21	.17	PCI/GM	LASLCHEM
205	PU239	1972	SOIL	19.0	9.03	3.26	.00	PCI/GM	LASL72
2120	PU239	1977	SOIL	2.5	14.30	7.16	.23	PCI/GM	LASLCHEM
2084	PU239	1977	SOIL	2.5	12.58	7.17	1.23	PCI/GM	LASLCHEM

2047	PU239	1977	SOIL	22.5	11.08	5.74	.01	PCI/GM	LASLCHEM
2014	PU239	1977	SOIL	12.5	7.37	2.22	.15	PCI/GM	LASLCHEM
104	PU239	1948	SOIL	1.3	8.99	3.23	1.30	PCI/GM	UCLA48
2072	PU239	1977	SOIL	7.5	9.86	4.42	3.88	PCI/GM	LASLCHEM
535	PU239	1973	SOIL	2.5	10.87	4.55	.54	NCI/M2	EPA
105	PU239	1948	SOIL	1.3	8.41	3.23	.50	PCI/GM	UCLA48
2052	PU239	1977	SOIL	7.5	11.11	5.55	.00	PCI/GM	LASLCHEM
2115	PU239	1977	SOIL	2.5	13.57	6.49	.23	PCI/GM	LASLCHEM
2016	PU239	1977	SOIL	12.5	7.24	2.33	.68	PCI/GM	LASLCHEM
2018	PU239	1977	SOIL	7.5	6.66	1.76	0.00	PCI/GM	LASLCHEM
18	PU239	1950	SOIL	1.3	14.72	7.12	.86	PCI/GM	UCLA50
2047	PU239	1977	SOIL	17.5	11.08	5.74	.01	PCI/GM	LASLCHEM
2003	PU239	1977	SOIL	12.5	6.63	.55	0.00	PCI/GM	LASLCHEM
204	PU239	1972	SOIL	1.3	8.45	2.59	.13	PCI/GM	LASL72
502	PU239	1973	SOIL	2.5	6.46	1.16	.31	NCI/M2	EPA
101	PU239	1948	SOIL	1.3	7.46	1.50	1.10	PCI/GM	UCLA48
2076	PU239	1977	SOIL	7.5	11.09	4.52	.02	PCI/GM	LASLCHEM
2084	PU239	1977	SOIL	7.5	12.58	7.17	.06	PCI/GM	LASLCHEM
2097	PU239	1977	SOIL	7.5	15.45	9.75	.15	PCI/GM	LASLCHEM
2018	PU239	1977	SOIL	2.5	6.66	1.76	.67	PCI/GM	LASLCHEM
526	PU239	1973	SOIL	2.5	7.91	3.31	12.00	NCI/M2	EPA
2027	PU239	1977	SOIL	12.5	10.28	4.20	.07	PCI/GM	LASLCHEM
2052	PU239	1977	SOIL	57.5	11.11	5.55	.01	PCI/GM	LASLCHEM
6	PU239	1950	SOIL	1.3	10.36	6.35	.40	PCI/GM	UCLA50
2026	PU239	1977	SOIL	7.5	10.05	4.07	.12	PCI/GM	LASLCHEM
2082	PU239	1977	SOIL	7.5	11.62	7.18	.01	PCI/GM	LASLCHEM
2001	PU239	1977	SOIL	7.5	6.63	.55	44.40	PCI/GM	LASLCHEM
202	PU239	1972	SOIL	5.0	7.23	1.23	0.00	PCI/GM	LASL72
2119	PU239	1977	SOIL	12.5	14.34	7.21	0.00	PCI/GM	LASLCHEM
204	PU239	1972	SOIL	19.0	8.45	2.59	.17	PCI/GM	LASL72
2057	PU239	1977	SOIL	2.5	10.35	5.34	.70	PCI/GM	LASLCHEM
109	PU239	1948	SOIL	1.3	9.67	4.57	1.30	PCI/GM	UCLA48
2060	PU239	1977	SOIL	7.5	9.91	5.07	.30	PCI/GM	LASLCHEM
2082	PU239	1977	SOIL	2.5	11.62	7.18	.95	PCI/GM	LASLCHEM
2057	PU239	1977	SOIL	7.5	10.35	5.34	.38	PCI/GM	LASLCHEM
2097	PU239	1977	SOIL	22.5	15.45	9.75	.00	PCI/GM	LASLCHEM
2084	PU239	1977	SOIL	12.5	12.58	7.17	.01	PCI/GM	LASLCHEM
3003	PU239	1977	SOIL	2.5	3.91	3.49	.01	PCI/GM	LASLCHEM
2028	PU239	1977	SOIL	7.5	10.37	4.33	.11	PCI/GM	LASLCHEM
2126	PU239	1977	SOIL	7.5	12.45	4.27	0.00	PCI/GM	LASLCHEM
2087	PU239	1977	SOIL	2.5	12.92	7.66	.00	PCI/GM	LASLCHEM
2060	PU239	1977	SOIL	22.5	9.91	5.07	.05	PCI/GM	LASLCHEM
574	PU239	1977	SOIL	2.5	17.51	11.20	6.10	NCI/M2	EPA
204	PU239	1972	SOIL	5.0	8.45	2.59	.75	PCI/GM	LASL72
542	PU239	1973	SOIL	2.5	10.30	5.37	28.00	NCI/M2	EPA
202	PU239	1972	SOIL	1.3	7.23	1.23	.43	PCI/GM	LASL72
539	PU239	1973	SOIL	2.5	12.28	3.54	1.30	NCI/M2	EPA
2118	PU239	1977	SOIL	12.5	14.55	6.45	0.00	PCI/GM	LASLCHEM
510	PU239	1973	SOIL	2.5	8.63	2.52	2.80	NCI/M2	EPA
2028	PU239	1977	SOIL	2.5	10.37	4.33	4.07	PCI/GM	LASLCHEM
2059	PU239	1977	SOIL	2.5	9.74	5.42	1.21	PCI/GM	LASLCHEM
2128	PU239	1977	SOIL	2.5	13.77	5.47	.06	PCI/GM	LASLCHEM
114	PU239	1948	SOIL	1.3	10.68	5.11	3.80	PCI/GM	UCLA48
208	PU239	1972	SOIL	19.0	10.80	5.26	.03	PCI/GM	LASL72
2049	PU239	1977	SOIL	2.5	11.11	5.55	.25	PCI/GM	LASLCHEM
2037	PU239	1977	SOIL	2.5	9.82	4.27	1.83	PCI/GM	LASLCHEM
100	PU239	1948	SOIL	1.3	7.10	1.09	.10	PCI/GM	UCLA48
208	PU239	1972	SOIL	1.3	10.80	5.26	1.44	PCI/GM	LASL72
115	PU239	1948	SOIL	1.3	9.90	5.10	.81	PCI/GM	UCLA48
2072	PU239	1977	SOIL	2.5	9.86	4.42	4.58	PCI/GM	LASLCHEM
1998	PU239	1977	SOIL	12.5	6.63	.55	.15	PCI/GM	LASLCHEM
207	PU239	1972	SOIL	1.3	10.22	4.59	.28	PCI/GM	LASL72
2088	PU239	1977	SOIL	2.5	13.22	7.66	.03	PCI/GM	LASLCHEM
206	PU239	1972	SOIL	1.3	9.59	3.89	.67	PCI/GM	LASL72
2080	PU239	1977	SOIL	7.5	10.91	7.22	.02	PCI/GM	LASLCHEM
203	PU239	1972	SOIL	1.3	7.81	1.89	.31	PCI/GM	LASL72
9	PU239	1950	SOIL	1.3	11.59	7.21	.20	PCI/GM	UCLA50
2021	PU239	1977	SOIL	2.5	9.60	4.33	2.24	PCI/GM	LASLCHEM
3001	PU239	1977	SOIL	7.5	3.91	3.49	0.00	PCI/GM	LASLCHEM
7	PU239	1950	SOIL	1.3	11.49	5.91	.40	PCI/GM	UCLA50
2115	PU239	1977	SOIL	12.5	13.57	6.49	0.00	PCI/GM	LASLCHEM
2001	PU239	1977	SOIL	2.5	6.63	.55	64.90	PCI/GM	LASLCHEM
2009	PU239	1977	SOIL	7.5	6.59	1.65	.45	PCI/GM	LASLCHEM
205	PU239	1972	SOIL	1.3	9.03	3.26	.29	PCI/GM	LASL72
106	PU239	1948	SOIL	1.3	9.90	3.23	0.00	PCI/GM	UCLA48
2065	PU239	1977	SOIL	12.5	10.39	5.01	0.00	PCI/GM	LASLCHEM
2048	PU239	1977	SOIL	2.5	11.09	5.87	.40	PCI/GM	LASLCHEM
2076	PU239	1977	SOIL	2.5	11.09	1.52	.44	PCI/GM	LASLCHEM
1998	PU239	1977	SOIL	7.5	6.63	.55	57.40	PCI/GM	LASLCHEM
2126	PU239	1977	SOIL	12.5	12.45	4.27	0.00	PCI/GM	LASLCHEM

2071	PU239	1977	SOIL	12.5	9.83	4.48	.06	PCI/GM	LASLCHEM
2028	PU239	1977	TH		10.37	4.33	.04	PCI/GM	CVEG
2055	RU103	1977	GR		11.35	5.86	1.31	PCI/GM	LLL GELI
1990	RU103	1977	GR		6.64	.55	0.00	PCI/GM	LLL GELI
2018	RU103	1977	GR		6.66	1.76	0.00	PCI/GM	LLL GELI
1988	RU103	1977	GR		6.64	.55	.57	PCI/GM	LLL GELI
2073	RU103	1977	INSITU		9.86	4.42	0.00	NCI/M2	LASL77
2022	RU103	1977	INSITU		9.60	4.32	1.42	NCI/M2	LASL77
2038	RU103	1977	INSITU		9.60	4.32	0.00	NCI/M2	LASL77
2144	RU103	1977	INSITU		10.46	7.19	0.00	NCI/M2	LASL77
2142	RU103	1977	INSITU		6.27	.00	0.00	NCI/M2	LASL77
2012	RU103	1977	INSITU		6.79	1.77	0.00	NCI/M2	LASL77
2031	RU103	1977	INSITU		10.41	4.28	0.00	NCI/M2	LASL77
2011	RU103	1977	INSITU		6.32	.00	0.00	NCI/M2	LASL77
2041	RU103	1977	INSITU		9.61	4.32	1.90	NCI/M2	LASL77
2125	RU103	1977	INSITU		14.68	4.45	1.01	NCI/M2	LASL77
2032	RU103	1977	INSITU		3.17	3.48	0.00	NCI/M2	LASL77
2026	RU103	1977	INSITU		10.05	4.07	0.00	NCI/M2	LASL77
2023	RU103	1977	INSITU		9.54	3.98	0.00	NCI/M2	LASL77
2052	RU103	1977	INSITU		11.11	5.55	0.00	NCI/M2	LASL77
2008	RU103	1977	INSITU		7.40	2.10	0.00	NCI/M2	LASL77
2033	RU103	1977	INSITU		3.14	3.57	0.00	NCI/M2	LASL77
2077	RU103	1977	INSITU		10.31	4.41	0.00	NCI/M2	LASL77
2007	RU103	1977	INSITU		7.10	2.07	1.48	NCI/M2	LASL77
2029	RU103	1977	INSITU		10.35	4.28	0.00	NCI/M2	LASL77
2039	RU103	1977	INSITU		9.60	4.32	0.00	NCI/M2	LASL77
2096	RU103	1977	INSITU		14.49	9.24	1.32	NCI/M2	LASL77
2019	RU103	1977	INSITU		6.69	2.24	.93	NCI/M2	LASL77
2146	RU103	1977	INSITU		9.82	4.27	0.00	NCI/M2	LASL77
2017	RU103	1977	INSITU		7.25	2.33	0.00	NCI/M2	LASL77
2116	RU103	1977	INSITU		13.74	6.12	0.00	NCI/M2	LASL77
2086	RU103	1977	INSITU		10.53	7.19	0.00	NCI/M2	LASL77
2139	RU103	1977	INSITU		6.58	.55	0.00	NCI/M2	LASL77
2115	RU103	1977	INSITU		13.57	6.49	.88	NCI/M2	LASL77
2092	RU103	1977	INSITU		13.52	9.21	1.12	NCI/M2	LASL77
2085	RU103	1977	INSITU		12.60	6.58	0.00	NCI/M2	LASL77
2079	RU103	1977	INSITU		10.53	7.20	0.00	NCI/M2	LASL77
1997	RU103	1977	INSITU		6.46	1.16	0.00	NCI/M2	LASL77
2080	RU103	1977	INSITU		10.91	7.22	1.04	NCI/M2	LASL77
2147	RU103	1977	INSITU		7.77	3.07	0.00	NCI/M2	LASL77
2132	RU103	1977	INSITU		6.70	2.16	0.00	NCI/M2	LASL77
2020	RU103	1977	INSITU		3.17	3.48	0.00	NCI/M2	LASL77
2120	RU103	1977	INSITU		14.30	7.16	1.59	NCI/M2	LASL77
2057	RU103	1977	INSITU		10.35	5.34	0.00	NCI/M2	LASL77
2016	RU103	1977	INSITU		7.24	2.33	0.00	NCI/M2	LASL77
2082	RU103	1977	INSITU		11.52	7.18	1.25	NCI/M2	LASL77
2123	RU103	1977	INSITU		13.68	6.79	0.00	NCI/M2	LASL77
2049	RU103	1977	INSITU		11.11	5.55	0.00	NCI/M2	LASL77
2097	RU103	1977	INSITU		15.45	9.75	0.00	NCI/M2	LASL77
2072	RU103	1977	INSITU		9.86	4.42	0.00	NCI/M2	LASL77
2118	RU103	1977	INSITU		14.55	6.45	0.00	NCI/M2	LASL77
2059	RU103	1977	INSITU		9.74	5.42	.94	NCI/M2	LASL77
2087	RU103	1977	INSITU		12.92	7.66	0.00	NCI/M2	LASL77
2134	RU103	1977	INSITU		6.58	.55	0.00	NCI/M2	LASL77
2101	RU103	1977	INSITU		16.52	14.74	0.00	NCI/M2	LASL77
2135	RU103	1977	INSITU		6.58	.55	0.00	NCI/M2	LASL77
2126	RU103	1977	INSITU		12.45	4.27	0.00	NCI/M2	LASL77
2122	RU103	1977	INSITU		13.69	6.87	0.00	NCI/M2	LASL77
2055	RU103	1977	INSITU		11.35	5.86	.87	NCI/M2	LASL77
2075	RU103	1977	INSITU		10.35	4.60	0.00	NCI/M2	LASL77
1996	RU103	1977	INSITU		6.45	.75	0.00	NCI/M2	LASL77
2010	RU103	1977	INSITU		6.79	1.71	0.00	NCI/M2	LASL77
2099	RU103	1977	INSITU		11.12	10.93	0.00	NCI/M2	LASL77
2136	RU103	1977	INSITU		6.58	.55	0.00	NCI/M2	LASL77
2053	RU103	1977	INSITU		10.69	5.56	0.00	NCI/M2	LASL77
2028	RU103	1977	INSITU		10.37	4.33	1.26	NCI/M2	LASL77
2095	RU103	1977	INSITU		14.49	9.25	0.00	NCI/M2	LASL77
2014	RU103	1977	INSITU		7.37	2.22	0.00	NCI/M2	LASL77
2015	RU103	1977	INSITU		7.37	2.31	.60	NCI/M2	LASL77
2009	RU103	1977	INSITU		6.59	1.65	0.00	NCI/M2	LASL77
2081	RU103	1977	INSITU		11.31	7.21	.75	NCI/M2	LASL77
2024	RU103	1977	INSITU		8.95	3.88	0.00	NCI/M2	LASL77
2066	RU103	1977	INSITU		10.60	4.42	0.00	NCI/M2	LASL77
2148	RU103	1977	INSITU		2.98	3.62	0.00	NCI/M2	LASL77
2068	RU103	1977	INSITU		9.30	5.02	0.00	NCI/M2	LASL77
2153	RU103	1977	INSITU		3.94	4.88	0.00	NCI/M2	LASL77
2027	RU103	1977	INSITU		10.28	4.20	.99	NCI/M2	LASL77
2018	RU103	1977	INSITU		6.66	1.76	0.00	NCI/M2	LASL77
2094	RU103	1977	INSITU		14.49	9.25	0.00	NCI/M2	LASL77
2006	RU103	1977	INSITU		7.07	2.04	0.00	NCI/M2	LASL77

2042	RU103	1977	INSITU		9.82	4.27	0.00	NCI/M2	LASL77
2034	RU103	1977	INSITU		3.16	3.70	0.00	NCI/M2	LASL77
2037	RU103	1977	INSITU		9.82	4.27	0.00	NCI/M2	LASL77
2127	RU103	1977	INSITU		13.40	5.21	0.00	NCI/M2	LASL77
2058	RU103	1977	INSITU		10.00	5.31	0.00	NCI/M2	LASL77
2154	RU103	1977	INSITU		3.95	4.57	0.00	NCI/M2	LASL77
2013	RU103	1977	INSITU		7.43	2.11	0.00	NCI/M2	LASL77
1998	RU103	1977	INSITU		6.63	.55	0.00	NCI/M2	LASL77
2141	RU103	1977	INSITU		6.58	.55	0.00	NCI/M2	LASL77
2130	RU103	1977	INSITU		6.03	.60	0.00	NCI/M2	LASL77
2062	RU103	1977	INSITU		9.83	5.10	0.00	NCI/M2	LASL77
2074	RU103	1977	INSITU		9.85	4.35	0.00	NCI/M2	LASL77
2067	RU103	1977	INSITU		9.31	4.96	0.00	NCI/M2	LASL77
2121	RU103	1977	INSITU		13.68	6.87	0.00	NCI/M2	LASL77
2084	RU103	1977	INSITU		12.58	7.17	0.00	NCI/M2	LASL77
2025	RU103	1977	INSITU		10.12	4.27	0.00	NCI/M2	LASL77
2065	RU103	1977	INSITU		10.39	5.01	0.00	NCI/M2	LASL77
2090	RU103	1977	INSITU		13.85	7.69	0.00	NCI/M2	LASL77
2047	RU103	1977	INSITU		11.08	5.74	0.00	NCI/M2	LASL77
2061	RU103	1977	INSITU		9.91	5.07	0.00	NCI/M2	LASL77
2088	RU103	1977	INSITU		13.22	7.66	.94	NCI/M2	LASL77
2048	RU103	1977	INSITU		11.09	5.87	1.02	NCI/M2	LASL77
2093	RU103	1977	INSITU		14.60	8.57	0.00	NCI/M2	LASL77
2128	RU103	1977	INSITU		13.77	5.47	0.00	NCI/M2	LASL77
2076	RU103	1977	INSITU		11.09	4.52	0.00	NCI/M2	LASL77
2064	RU103	1977	INSITU		10.54	7.19	0.00	NCI/M2	LASL77
2131	RU103	1977	INSITU		6.62	1.87	0.00	NCI/M2	LASL77
2129	RU103	1977	INSITU		6.27	0.00	0.00	NCI/M2	LASL77
2083	RU103	1977	INSITU		12.14	7.19	0.00	NCI/M2	LASL77
2043	RU103	1977	INSITU		3.91	3.49	0.00	NCI/M2	LASL77
2071	RU103	1977	INSITU		9.83	4.48	0.00	NCI/M2	LASL77
2155	RU103	1977	INSITU		3.91	3.49	.83	NCI/M2	LASL77
2143	RU103	1977	INSITU		4.81	3.00	0.00	NCI/M2	LASL77
2114	RU103	1977	INSITU		10.46	7.18	.95	NCI/M2	LASL77
2030	RU103	1977	INSITU		10.39	4.30	0.00	NCI/M2	LASL77
2100	RU103	1977	INSITU		14.50	12.20	0.00	NCI/M2	LASL77
2140	RU103	1977	INSITU		6.58	.55	0.00	NCI/M2	LASL77
2060	RU103	1977	INSITU		9.91	5.07	0.00	NCI/M2	LASL77
2050	RU103	1977	INSITU		11.11	5.55	1.12	NCI/M2	LASL77
2040	RU103	1977	INSITU		9.60	4.32	0.00	NCI/M2	LASL77
2138	RU103	1977	INSITU		5.81	2.17	0.00	NCI/M2	LASL77
2119	RU103	1977	INSITU		14.34	7.21	0.00	NCI/M2	LASL77
2049	RU103	1977	SG		11.11	5.55	.50	PCI/GM	LLL GELI
2007	RU103	1977	SK		7.10	2.07	1.17	PCI/GM	LLL GELI
1987	RU103	1977	SK		6.63	.55	0.00	PCI/GM	LLL GELI
2016	RU103	1977	SK		7.24	2.33	1.06	PCI/GM	LLL GELI
1991	RU103	1977	SK		6.63	.55	.35	PCI/GM	LLL GELI
2045	RU103	1977	SK		10.52	5.51	0.00	PCI/GM	LLL GELI
2028	RU103	1977	TH		10.37	4.33	0.00	PCI/GM	LLL GELI
2052	RU103	1977	UK		11.11	5.55	0.00	PCI/GM	LLL GELI
2018	SR90	1977	GR		6.66	1.76	.50	PCI/GM	CVEG
2028	SR90	1977	GR		10.37	4.33	15	PCI/GM	CVEG
2048	SR90	1977	GR		11.09	5.87	.50	PCI/GM	CVEG
2019	SR90	1977	OTHER		6.69	2.24	.19	PCI/GM	CVEG
2052	SR90	1977	OTHER		11.11	5.55	.23	PCI/GM	CVEG
2018	SR90	1977	SK		6.66	1.76	.24	PCI/GM	CVEG
1995	SR90	1977	SK		6.66	.76	.11	PCI/GM	CVEG
2018	SR90	1977	SOIL	2.5	6.66	1.76	.50	PCI/GM	LASLCHEM
2072	SR90	1977	SOIL	2.5	9.86	4.42	5.50	PCI/GM	LASLCHEM
2052	SR90	1977	SOIL	12.5	11.11	5.55	.22	PCI/GM	LASLCHEM
2014	SR90	1977	SOIL	2.5	7.37	2.22	.42	PCI/GM	LASLCHEM
2016	SR90	1977	SOIL	12.5	7.24	2.33	1.60	PCI/GM	LASLCHEM
2016	SR90	1977	SOIL	7.5	7.24	2.33	.37	PCI/GM	LASLCHEM
2073	SR90	1977	SOIL	2.5	9.86	4.42	6.80	PCI/GM	LASLCHEM
2052	SR90	1977	SOIL	22.5	11.11	5.55	.26	PCI/GM	LASLCHEM
2121	SR90	1977	SOIL	2.5	13.68	6.87	3.50	PCI/GM	LASLCHEM
2121	SR90	1977	SOIL	7.5	13.68	6.87	2.16	PCI/GM	LASLCHEM
2028	SR90	1977	SOIL	2.5	10.37	4.33	.20	PCI/GM	LASLCHEM
2048	SR90	1977	SOIL	2.5	11.09	5.87	.30	PCI/GM	LASLCHEM
2019	SR90	1977	SOIL	7.5	6.69	2.24	.57	PCI/GM	LASLCHEM
2097	SR90	1977	SOIL	2.5	15.45	9.75	.88	PCI/GM	LASLCHEM
2052	SR90	1977	SOIL	42.5	11.11	5.55	.09	PCI/GM	LASLCHEM
2060	SR90	1977	SOIL	22.5	9.91	5.07	.51	PCI/GM	LASLCHEM
2071	SR90	1977	SOIL	2.5	9.83	4.48	1.65	PCI/GM	LASLCHEM
2097	SR90	1977	SOIL	22.5	15.45	9.75	.21	PCI/GM	LASLCHEM
2118	SR90	1977	SOIL	2.5	14.55	6.45	.71	PCI/GM	LASLCHEM
2072	SR90	1977	SOIL	12.5	9.86	4.42	1.69	PCI/GM	LASLCHEM
2060	SR90	1977	SOIL	2.5	9.91	5.07	1.32	PCI/GM	LASLCHEM
2018	SR90	1977	SOIL	12.5	6.66	1.76	.10	PCI/GM	LASLCHEM
2014	SR90	1977	SOIL	12.5	7.37	2.22	.39	PCI/GM	LASLCHEM

2052	SR90	1977	SOIL	2.5	11.11	5.55	.43	PCI/GM	LASLCHEM
2060	SR90	1977	SOIL	12.5	9.91	5.07	.38	PCI/GM	LASLCHEM
2125	SR90	1977	SOIL	2.5	14.68	4.45	.78	PCI/GM	LASLCHEM
2097	SR90	1977	SOIL	12.5	15.45	9.75	.30	PCI/GM	LASLCHEM
2014	SR90	1977	SOIL	7.5	7.37	2.22	.41	PCI/GM	LASLCHEM
2018	SR90	1977	SOIL	7.5	6.66	1.76	.17	PCI/GM	LASLCHEM
2016	SR90	1977	SOIL	2.5	7.24	2.33	.30	PCI/GM	LASLCHEM
2019	SR90	1977	SOIL	2.5	6.69	2.24	6.00	PCI/GM	LASLCHEM
2135	TH232	1977	INSITU		6.58	.55	.81	PCI/GM	LASL77
2007	TH232	1977	INSITU		7.10	2.07	.83	PCI/GM	LASL77
2084	TH232	1977	INSITU		12.58	7.17	1.10	PCI/GM	LASL77
2052	TH232	1977	INSITU		11.11	5.55	1.39	PCI/GM	LASL77
2006	TH232	1977	INSITU		7.07	2.04	.96	PCI/GM	LASL77
2081	TH232	1977	INSITU		11.31	7.21	.63	PCI/GM	LASL77
2012	TH232	1977	INSITU		6.79	1.77	1.12	PCI/GM	LASL77
2029	TH232	1977	INSITU		10.35	4.28	.96	PCI/GM	LASL77
2101	TH232	1977	INSITU		16.52	14.74	.96	PCI/GM	LASL77
2059	TH232	1977	INSITU		9.74	5.42	.98	PCI/GM	LASL77
2083	TH232	1977	INSITU		12.14	7.19	.54	PCI/GM	LASL77
2090	TH232	1977	INSITU		13.85	7.69	2.28	PCI/GM	LASL77
2114	TH232	1977	INSITU		10.46	7.18	.41	PCI/GM	LASL77
2058	TH232	1977	INSITU		10.00	5.31	1.09	PCI/GM	LASL77
2088	TH232	1977	INSITU		13.22	7.66	1.04	PCI/GM	LASL77
2071	TH232	1977	INSITU		9.83	4.48	1.02	PCI/GM	LASL77
2015	TH232	1977	INSITU		7.37	2.31	.29	PCI/GM	LASL77
2060	TH232	1977	INSITU		9.91	5.07	1.32	PCI/GM	LASL77
2120	TH232	1977	INSITU		14.30	7.16	1.28	PCI/GM	LASL77
2096	TH232	1977	INSITU		14.49	9.24	.61	PCI/GM	LASL77
2153	TH232	1977	INSITU		3.94	4.88	.64	PCI/GM	LASL77
2040	TH232	1977	INSITU		9.60	4.32	.65	PCI/GM	LASL77
2123	TH232	1977	INSITU		13.68	6.79	2.03	PCI/GM	LASL77
2086	TH232	1977	INSITU		10.53	7.19	.45	PCI/GM	LASL77
2075	TH232	1977	INSITU		10.85	4.60	.75	PCI/GM	LASL77
2127	TH232	1977	INSITU		13.40	5.21	1.18	PCI/GM	LASL77
2067	TH232	1977	INSITU		9.31	4.96	.36	PCI/GM	LASL77
2062	TH232	1977	INSITU		9.83	5.10	.88	PCI/GM	LASL77
2019	TH232	1977	INSITU		6.69	2.24	.51	PCI/GM	LASL77
2057	TH232	1977	INSITU		10.35	5.34	.94	PCI/GM	LASL77
2093	TH232	1977	INSITU		14.60	8.57	.89	PCI/GM	LASL77
2126	TH232	1977	INSITU		12.45	4.27	.96	PCI/GM	LASL77
2141	TH232	1977	INSITU		6.58	.55	.95	PCI/GM	LASL77
2073	TH232	1977	INSITU		9.86	4.42	1.33	PCI/GM	LASL77
2032	TH232	1977	INSITU		3.17	3.48	1.32	PCI/GM	LASL77
2132	TH232	1977	INSITU		6.70	2.16	.47	PCI/GM	LASL77
2085	TH232	1977	INSITU		12.60	6.58	.89	PCI/GM	LASL77
2079	TH232	1977	INSITU		10.53	7.20	.45	PCI/GM	LASL77
2047	TH232	1977	INSITU		11.08	5.74	.73	PCI/GM	LASL77
2049	TH232	1977	INSITU		11.11	5.55	.71	PCI/GM	LASL77
2115	TH232	1977	INSITU		13.57	6.49	1.00	PCI/GM	LASL77
2118	TH232	1977	INSITU		14.55	6.45	1.27	PCI/GM	LASL77
2134	TH232	1977	INSITU		6.58	.55	.79	PCI/GM	LASL77
2042	TH232	1977	INSITU		9.82	4.27	1.36	PCI/GM	LASL77
2018	TH232	1977	INSITU		6.66	1.76	.71	PCI/GM	LASL77
2072	TH232	1977	INSITU		9.86	4.42	1.21	PCI/GM	LASL77
2025	TH232	1977	INSITU		10.12	4.27	.80	PCI/GM	LASL77
2148	TH232	1977	INSITU		2.98	3.62	.14	PCI/GM	LASL77
2116	TH232	1977	INSITU		13.74	6.12	1.35	PCI/GM	LASL77
2138	TH232	1977	INSITU		5.81	2.17	.84	PCI/GM	LASL77
2013	TH232	1977	INSITU		7.43	2.11	1.23	PCI/GM	LASL77
2094	TH232	1977	INSITU		14.49	9.25	.87	PCI/GM	LASL77
2128	TH232	1977	INSITU		13.77	5.47	1.45	PCI/GM	LASL77
2020	TH232	1977	INSITU		3.17	3.48	.97	PCI/GM	LASL77
2080	TH232	1977	INSITU		10.91	7.22	.47	PCI/GM	LASL77
2099	TH232	1977	INSITU		11.12	10.93	.39	PCI/GM	LASL77
2095	TH232	1977	INSITU		14.49	9.25	.67	PCI/GM	LASL77
1996	TH232	1977	INSITU		6.45	.75	.95	PCI/GM	LASL77
2155	TH232	1977	INSITU		3.91	3.49	.95	PCI/GM	LASL77
2077	TH232	1977	INSITU		10.31	4.41	.91	PCI/GM	LASL77
2024	TH232	1977	INSITU		8.95	3.88	.83	PCI/GM	LASL77
2154	TH232	1977	INSITU		3.95	4.57	.54	PCI/GM	LASL77
2065	TH232	1977	INSITU		10.39	5.01	.73	PCI/GM	LASL77
2140	TH232	1977	INSITU		6.58	.55	.97	PCI/GM	LASL77
2129	TH232	1977	INSITU		6.27	0.00	.87	PCI/GM	LASL77
2017	TH232	1977	INSITU		7.25	2.33	1.47	PCI/GM	LASL77
2068	TH232	1977	INSITU		9.30	5.02	1.08	PCI/GM	LASL77
2008	TH232	1977	INSITU		7.40	2.10	.76	PCI/GM	LASL77
2048	TH232	1977	INSITU		11.09	5.87	.64	PCI/GM	LASL77
2010	TH232	1977	INSITU		6.79	1.71	.71	PCI/GM	LASL77
1998	TH232	1977	INSITU		6.63	.55	.93	PCI/GM	LASL77
2144	TH232	1977	INSITU		10.46	7.19	.36	PCI/GM	LASL77

2014	TH232	1977	INSITU	7.37	2.22	1.82	PCI/GM	LASL77
2147	TH232	1977	INSITU	7.77	3.07	.64	PCI/GM	LASL77
2076	TH232	1977	INSITU	11.09	4.32	.43	PCI/GM	LASL77
2037	TH232	1977	INSITU	9.82	4.27	1.24	PCI/GM	LASL77
2119	TH232	1977	INSITU	14.34	7.21	.84	PCI/GM	LASL77
2038	TH232	1977	INSITU	9.60	4.32	.64	PCI/GM	LASL77
2033	TH232	1977	INSITU	3.14	3.57	1.03	PCI/GM	LASL77
2009	TH232	1977	INSITU	6.59	1.65	1.39	PCI/GM	LASL77
1997	TH232	1977	INSITU	6.46	1.16	.50	PCI/GM	LASL77
2016	TH232	1977	INSITU	7.24	2.33	1.22	PCI/GM	LASL77
2082	TH232	1977	INSITU	11.62	7.18	1.09	PCI/GM	LASL77
2034	TH232	1977	INSITU	3.16	3.70	1.15	PCI/GM	LASL77
2030	TH232	1977	INSITU	10.39	4.30	1.11	PCI/GM	LASL77
2023	TH232	1977	INSITU	9.54	3.98	1.00	PCI/GM	LASL77
2027	TH232	1977	INSITU	10.28	4.20	.47	PCI/GM	LASL77
2139	TH232	1977	INSITU	6.58	.55	.89	PCI/GM	LASL77
2074	TH232	1977	INSITU	9.85	4.35	.81	PCI/GM	LASL77
2092	TH232	1977	INSITU	13.52	9.21	.31	PCI/GM	LASL77
2055	TH232	1977	INSITU	11.35	5.86	.98	PCI/GM	LASL77
2136	TH232	1977	INSITU	6.58	.55	.78	PCI/GM	LASL77
2142	TH232	1977	INSITU	6.27	.00	.79	PCI/GM	LASL77
2143	TH232	1977	INSITU	4.81	3.00	.71	PCI/GM	LASL77
2031	TH232	1977	INSITU	10.41	4.28	.78	PCI/GM	LASL77
2026	TH232	1977	INSITU	10.05	4.07	1.17	PCI/GM	LASL77
2087	TH232	1977	INSITU	12.92	7.66	1.19	PCI/GM	LASL77
2011	TH232	1977	INSITU	6.32	.00	1.06	PCI/GM	LASL77
2066	TH232	1977	INSITU	10.60	4.42	1.22	PCI/GM	LASL77
2097	TH232	1977	INSITU	15.45	9.75	1.04	PCI/GM	LASL77
2130	TH232	1977	INSITU	6.03	.60	1.52	PCI/GM	LASL77
2125	TH232	1977	INSITU	14.68	4.45	1.49	PCI/GM	LASL77
2028	TH232	1977	INSITU	10.37	4.33	1.08	PCI/GM	LASL77
2050	TH232	1977	INSITU	11.11	5.55	.67	PCI/GM	LASL77
2064	TH232	1977	INSITU	10.54	7.19	.46	PCI/GM	LASL77
2053	TH232	1977	INSITU	10.69	5.56	.49	PCI/GM	LASL77
2041	TH232	1977	INSITU	9.61	4.32	.84	PCI/GM	LASL77
2043	TH232	1977	INSITU	3.91	3.49	.69	PCI/GM	LASL77
2039	TH232	1977	INSITU	9.60	4.32	.68	PCI/GM	LASL77
2022	TH232	1977	INSITU	9.60	4.32	.98	PCI/GM	LASL77
2100	TH232	1977	INSITU	14.50	12.20	1.09	PCI/GM	LASL77
2121	TH232	1977	INSITU	13.68	6.87	2.80	PCI/GM	LASL77
2061	TH232	1977	INSITU	9.91	5.07	1.42	PCI/GM	LASL77
2146	TH232	1977	INSITU	9.82	4.27	.45	PCI/GM	LASL77
2122	TH232	1977	INSITU	13.69	6.87	2.74	PCI/GM	LASL77
2131	TH232	1977	INSITU	6.62	1.87	.70	PCI/GM	LASL77
2017	U238	1977	INSITU	7.25	2.33	1.45	PCI/GM	LASL77
2029	U238	1977	INSITU	10.35	4.28	.82	PCI/GM	LASL77
2057	U238	1977	INSITU	10.35	5.34	.83	PCI/GM	LASL77
2043	U238	1977	INSITU	3.91	3.49	1.01	PCI/GM	LASL77
2019	U238	1977	INSITU	6.69	2.24	.58	PCI/GM	LASL77
2058	U238	1977	INSITU	10.00	5.31	.89	PCI/GM	LASL77
2015	U238	1977	INSITU	7.37	2.31	.69	PCI/GM	LASL77
2093	U238	1977	INSITU	14.60	8.57	.85	PCI/GM	LASL77
2010	U238	1977	INSITU	6.79	1.71	.65	PCI/GM	LASL77
2129	U238	1977	INSITU	6.27	0.00	.76	PCI/GM	LASL77
2090	U238	1977	INSITU	13.85	7.69	1.29	PCI/GM	LASL77
2128	U238	1977	INSITU	13.77	5.47	1.06	PCI/GM	LASL77
2012	U238	1977	INSITU	6.79	1.77	.93	PCI/GM	LASL77
2080	U238	1977	INSITU	10.91	7.22	.69	PCI/GM	LASL77
2142	U238	1977	INSITU	6.27	.00	.77	PCI/GM	LASL77
2147	U238	1977	INSITU	7.77	3.07	.75	PCI/GM	LASL77
2052	U238	1977	INSITU	11.11	5.55	.93	PCI/GM	LASL77
2062	U238	1977	INSITU	9.83	5.10	.85	PCI/GM	LASL77
2048	U238	1977	INSITU	11.09	5.87	1.41	PCI/GM	LASL77
2138	U238	1977	INSITU	5.81	2.17	.68	PCI/GM	LASL77
2060	U238	1977	INSITU	9.91	5.07	.82	PCI/GM	LASL77
2155	U238	1977	INSITU	3.91	3.49	1.04	PCI/GM	LASL77
2016	U238	1977	INSITU	7.24	2.33	1.15	PCI/GM	LASL77
2027	U238	1977	INSITU	10.28	4.20	.71	PCI/GM	LASL77
2131	U238	1977	INSITU	6.62	1.87	.68	PCI/GM	LASL77
2024	U238	1977	INSITU	8.95	3.88	1.81	PCI/GM	LASL77
2064	U238	1977	INSITU	10.54	7.19	.47	PCI/GM	LASL77
2132	U238	1977	INSITU	6.70	2.16	.64	PCI/GM	LASL77
2141	U238	1977	INSITU	6.58	.55	.72	PCI/GM	LASL77
2022	U238	1977	INSITU	9.60	4.32	.84	PCI/GM	LASL77
2146	U238	1977	INSITU	9.82	4.27	.57	PCI/GM	LASL77
2154	U238	1977	INSITU	3.95	4.57	.67	PCI/GM	LASL77
2025	U238	1977	INSITU	10.12	4.27	.91	PCI/GM	LASL77
2085	U238	1977	INSITU	12.60	6.58	.96	PCI/GM	LASL77
2034	U238	1977	INSITU	3.16	3.70	1.11	PCI/GM	LASL77
2014	U238	1977	INSITU	7.37	2.22	1.27	PCI/GM	LASL77

2071	U238	1977	INSITU	9.83	4.48	.96 PCI/GM	LASL77
2028	U238	1977	INSITU	10.37	4.33	.90 PCI/GM	LASL77
2032	U238	1977	INSITU	3.17	3.48	1.11 PCI/GM	LASL77
2127	U238	1977	INSITU	13.40	5.21	.93 PCI/GM	LASL77
2086	U238	1977	INSITU	10.53	7.19	.43 PCI/GM	LASL77
2049	U238	1977	INSITU	11.11	5.55	.71 PCI/GM	LASL77
2099	U238	1977	INSITU	11.12	10.93	.51 PCI/GM	LASL77
2130	U238	1977	INSITU	6.03	.60	1.23 PCI/GM	LASL77
2095	U238	1977	INSITU	14.49	9.25	.63 PCI/GM	LASL77
2047	U238	1977	INSITU	11.08	5.74	1.54 PCI/GM	LASL77
2118	U238	1977	INSITU	14.55	6.45	.96 PCI/GM	LASL77
2148	U238	1977	INSITU	2.98	3.62	.96 PCI/GM	LASL77
2068	U238	1977	INSITU	9.30	5.02	.96 PCI/GM	LASL77
2077	U238	1977	INSITU	10.31	4.41	.91 PCI/GM	LASL77
2084	U238	1977	INSITU	12.58	7.17	.93 PCI/GM	LASL77
2011	U238	1977	INSITU	6.32	.00	.89 PCI/GM	LASL77
2007	U238	1977	INSITU	7.10	2.07	.75 PCI/GM	LASL77
2088	U238	1977	INSITU	13.22	7.66	1.71 PCI/GM	LASL77
2092	U238	1977	INSITU	13.52	9.21	.43 PCI/GM	LASL77
2139	U238	1977	INSITU	6.58	.55	.65 PCI/GM	LASL77
2039	U238	1977	INSITU	9.60	4.32	1.04 PCI/GM	LASL77
2038	U238	1977	INSITU	9.60	4.32	1.05 PCI/GM	LASL77
2121	U238	1977	INSITU	13.68	6.87	1.17 PCI/GM	LASL77
2037	U238	1977	INSITU	9.82	4.27	1.02 PCI/GM	LASL77
2031	U238	1977	INSITU	10.41	4.28	.75 PCI/GM	LASL77
2136	U238	1977	INSITU	6.58	.55	.56 PCI/GM	LASL77
2076	U238	1977	INSITU	11.09	4.52	.71 PCI/GM	LASL77
2041	U238	1977	INSITU	9.61	4.32	1.01 PCI/GM	LASL77
2087	U238	1977	INSITU	12.92	7.66	.93 PCI/GM	LASL77
2125	U238	1977	INSITU	14.68	4.45	1.18 PCI/GM	LASL77
2096	U238	1977	INSITU	14.49	9.24	.78 PCI/GM	LASL77
2115	U238	1977	INSITU	13.57	6.49	.95 PCI/GM	LASL77
2082	U238	1977	INSITU	11.62	7.18	.88 PCI/GM	LASL77
2119	U238	1977	INSITU	14.34	7.21	.68 PCI/GM	LASL77
2008	U238	1977	INSITU	7.40	2.10	.83 PCI/GM	LASL77
2026	U238	1977	INSITU	10.05	4.07	.96 PCI/GM	LASL77
2094	U238	1977	INSITU	14.49	9.25	.73 PCI/GM	LASL77
2123	U238	1977	INSITU	13.68	6.79	.98 PCI/GM	LASL77
2122	U238	1977	INSITU	13.69	6.87	1.39 PCI/GM	LASL77
2013	U238	1977	INSITU	7.43	2.11	.98 PCI/GM	LASL77
2120	U238	1977	INSITU	14.30	7.16	.92 PCI/GM	LASL77
2067	U238	1977	INSITU	9.31	4.96	.75 PCI/GM	LASL77
1998	U238	1977	INSITU	6.63	.55	.89 PCI/GM	LASL77
2009	U238	1977	INSITU	6.59	1.65	1.20 PCI/GM	LASL77
2079	U238	1977	INSITU	10.53	7.20	.68 PCI/GM	LASL77
2081	U238	1977	INSITU	11.31	7.21	.77 PCI/GM	LASL77
2116	U238	1977	INSITU	13.74	6.12	1.00 PCI/GM	LASL77
2153	U238	1977	INSITU	3.94	4.80	1.31 PCI/GM	LASL77
2140	U238	1977	INSITU	6.58	.55	.77 PCI/GM	LASL77
2083	U238	1977	INSITU	12.14	7.19	.79 PCI/GM	LASL77
2101	U238	1977	INSITU	16.52	14.74	.81 PCI/GM	LASL77
2023	U238	1977	INSITU	9.54	3.98	1.08 PCI/GM	LASL77
2100	U238	1977	INSITU	14.50	12.20	1.02 PCI/GM	LASL77
2059	U238	1977	INSITU	9.74	5.42	.96 PCI/GM	LASL77
2030	U238	1977	INSITU	10.39	4.30	.88 PCI/GM	LASL77
2097	U238	1977	INSITU	15.45	9.75	1.03 PCI/GM	LASL77
1997	U238	1977	INSITU	8.46	1.16	.48 PCI/GM	LASL77
2074	U238	1977	INSITU	9.85	4.35	.94 PCI/GM	LASL77
2061	U238	1977	INSITU	9.91	5.07	.89 PCI/GM	LASL77
2042	U238	1977	INSITU	9.82	4.27	1.02 PCI/GM	LASL77
2055	U238	1977	INSITU	11.35	5.86	.73 PCI/GM	LASL77
2114	U238	1977	INSITU	10.46	7.18	.54 PCI/GM	LASL77
2072	U238	1977	INSITU	9.86	4.42	.95 PCI/GM	LASL77
2065	U238	1977	INSITU	10.39	5.01	.91 PCI/GM	LASL77
2018	U238	1977	INSITU	6.66	1.76	.71 PCI/GM	LASL77
2040	U238	1977	INSITU	9.60	4.32	1.02 PCI/GM	LASL77
2053	U238	1977	INSITU	10.69	5.56	.80 PCI/GM	LASL77
2135	U238	1977	INSITU	6.58	.55	0.00 PCI/GM	LASL77
2144	U238	1977	INSITU	10.46	7.19	.34 PCI/GM	LASL77
2020	U238	1977	INSITU	3.17	3.48	2.04 PCI/GM	LASL77
2006	U238	1977	INSITU	7.07	2.04	1.02 PCI/GM	LASL77
2066	U238	1977	INSITU	10.60	4.42	.91 PCI/GM	LASL77
2073	U238	1977	INSITU	9.86	4.42	1.05 PCI/GM	LASL77
2134	U238	1977	INSITU	6.58	.55	.88 PCI/GM	LASL77
2143	U238	1977	INSITU	4.81	3.00	.85 PCI/GM	LASL77
2126	U238	1977	INSITU	12.45	4.27	.83 PCI/GM	LASL77
2033	U238	1977	INSITU	3.14	3.57	1.34 PCI/GM	LASL77
2050	U238	1977	INSITU	11.11	5.55	.72 PCI/GM	LASL77
2075	U238	1977	INSITU	10.85	4.60	.71 PCI/GM	LASL77
1996	U238	1977	INSITU	6.45	.75	.93 PCI/GM	LASL77

2055	ZR95	1977	GR	11.35	5.86	5.80	PCI/GM	LLL GELI
1990	ZR95	1977	GR	6.64	.55	2.99	PCI/GM	LLL GELI
2018	ZR95	1977	GR	6.66	1.76	3.54	PCI/GM	LLL GELI
1988	ZR95	1977	GR	6.64	.55	2.33	PCI/GM	LLL GELI
2140	ZR95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2024	ZR95	1977	INSITU	8.95	3.88	2.58	NCI/M2	LASL77
2019	ZR95	1977	INSITU	6.69	2.24	2.37	NCI/M2	LASL77
2093	ZR95	1977	INSITU	14.60	8.57	2.75	NCI/M2	LASL77
2097	ZR95	1977	INSITU	15.45	9.75	3.05	NCI/M2	LASL77
2022	ZR95	1977	INSITU	9.60	4.32	2.88	NCI/M2	LASL77
2028	ZR95	1977	INSITU	10.37	4.33	3.41	NCI/M2	LASL77
2039	ZR95	1977	INSITU	9.60	4.32	1.57	NCI/M2	LASL77
2047	ZR95	1977	INSITU	11.08	5.74	3.33	NCI/M2	LASL77
2138	ZR95	1977	INSITU	5.81	2.17	5.04	NCI/M2	LASL77
2081	ZR95	1977	INSITU	11.31	7.21	2.86	NCI/M2	LASL77
2076	ZR95	1977	INSITU	11.09	4.52	2.74	NCI/M2	LASL77
2119	ZR95	1977	INSITU	14.34	7.21	3.57	NCI/M2	LASL77
2094	ZR95	1977	INSITU	14.49	9.25	2.79	NCI/M2	LASL77
2017	ZR95	1977	INSITU	7.25	2.33	2.86	NCI/M2	LASL77
2096	ZR95	1977	INSITU	14.49	9.24	2.56	NCI/M2	LASL77
2118	ZR95	1977	INSITU	14.55	6.45	3.16	NCI/M2	LASL77
2087	ZR95	1977	INSITU	12.92	7.66	2.84	NCI/M2	LASL77
2052	ZR95	1977	INSITU	11.11	5.55	3.12	NCI/M2	LASL77
2059	ZR95	1977	INSITU	9.74	5.42	2.30	NCI/M2	LASL77
2123	ZR95	1977	INSITU	14.68	4.45	3.24	NCI/M2	LASL77
2086	ZR95	1977	INSITU	10.53	7.19	2.27	NCI/M2	LASL77
2088	ZR95	1977	INSITU	13.22	7.66	5.82	NCI/M2	LASL77
2010	ZR95	1977	INSITU	6.79	1.71	2.57	NCI/M2	LASL77
2037	ZR95	1977	INSITU	9.82	4.27	3.28	NCI/M2	LASL77
2143	ZR95	1977	INSITU	4.81	3.00	0.00	NCI/M2	LASL77
2134	ZR95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2061	ZR95	1977	INSITU	9.91	5.07	2.90	NCI/M2	LASL77
2023	ZR95	1977	INSITU	9.54	3.98	2.74	NCI/M2	LASL77
2121	ZR95	1977	INSITU	13.68	6.87	2.95	NCI/M2	LASL77
2080	ZR95	1977	INSITU	10.91	7.22	2.98	NCI/M2	LASL77
2073	ZR95	1977	INSITU	9.86	4.42	3.19	NCI/M2	LASL77
2042	ZR95	1977	INSITU	9.82	4.27	3.02	NCI/M2	LASL77
2083	ZR95	1977	INSITU	12.14	7.19	2.42	NCI/M2	LASL77
2033	ZR95	1977	INSITU	3.14	3.57	1.45	NCI/M2	LASL77
1997	ZR95	1977	INSITU	6.46	1.16	1.01	NCI/M2	LASL77
2074	ZR95	1977	INSITU	9.85	4.35	2.21	NCI/M2	LASL77
2123	ZR95	1977	INSITU	13.68	6.79	0.00	NCI/M2	LASL77
2095	ZR95	1977	INSITU	14.49	9.25	2.17	NCI/M2	LASL77
2147	ZR95	1977	INSITU	7.77	3.07	0.00	NCI/M2	LASL77
1996	ZR95	1977	INSITU	6.45	.75	3.04	NCI/M2	LASL77
2049	ZR95	1977	INSITU	11.11	5.55	3.05	NCI/M2	LASL77
2057	ZR95	1977	INSITU	10.35	5.34	3.32	NCI/M2	LASL77
2040	ZR95	1977	INSITU	9.60	4.32	3.12	NCI/M2	LASL77
2072	ZR95	1977	INSITU	9.86	4.42	3.32	NCI/M2	LASL77
2026	ZR95	1977	INSITU	10.05	4.07	2.99	NCI/M2	LASL77
2065	ZR95	1977	INSITU	10.39	5.01	0.00	NCI/M2	LASL77
2011	ZR95	1977	INSITU	6.32	.00	2.44	NCI/M2	LASL77
2122	ZR95	1977	INSITU	13.69	6.87	3.32	NCI/M2	LASL77
2013	ZR95	1977	INSITU	7.43	2.11	2.46	NCI/M2	LASL77
2136	ZR95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2155	ZR95	1977	INSITU	3.91	3.49	2.62	NCI/M2	LASL77
2092	ZR95	1977	INSITU	13.52	9.21	2.56	NCI/M2	LASL77
2016	ZR95	1977	INSITU	7.24	2.33	3.78	NCI/M2	LASL77
2029	ZR95	1977	INSITU	10.35	4.28	4.11	NCI/M2	LASL77
2130	ZR95	1977	INSITU	6.03	.60	0.00	NCI/M2	LASL77
2077	ZR95	1977	INSITU	10.31	4.41	3.38	NCI/M2	LASL77
2038	ZR95	1977	INSITU	9.60	4.32	2.33	NCI/M2	LASL77
2067	ZR95	1977	INSITU	9.31	4.96	0.00	NCI/M2	LASL77
2100	ZR95	1977	INSITU	14.50	12.20	2.76	NCI/M2	LASL77
2101	ZR95	1977	INSITU	16.52	14.74	3.78	NCI/M2	LASL77
2060	ZR95	1977	INSITU	9.91	5.07	2.39	NCI/M2	LASL77
2144	ZR95	1977	INSITU	10.46	7.19	1.52	NCI/M2	LASL77
2034	ZR95	1977	INSITU	3.16	3.70	2.41	NCI/M2	LASL77
2127	ZR95	1977	INSITU	13.40	5.21	2.56	NCI/M2	LASL77
2129	ZR95	1977	INSITU	6.27	0.00	1.78	NCI/M2	LASL77
2012	ZR95	1977	INSITU	6.79	1.77	3.22	NCI/M2	LASL77
2154	ZR95	1977	INSITU	3.95	4.57	1.36	NCI/M2	LASL77
2128	ZR95	1977	INSITU	13.77	5.47	2.12	NCI/M2	LASL77
2114	ZR95	1977	INSITU	10.46	7.18	0.00	NCI/M2	LASL77
2025	ZR95	1977	INSITU	10.12	4.27	2.89	NCI/M2	LASL77
2018	ZR95	1977	INSITU	6.66	1.76	3.05	NCI/M2	LASL77
2068	ZR95	1977	INSITU	9.30	5.02	3.53	NCI/M2	LASL77
2015	ZR95	1977	INSITU	7.37	2.31	2.22	NCI/M2	LASL77
2075	ZR95	1977	INSITU	10.85	4.60	2.09	NCI/M2	LASL77
2064	ZR95	1977	INSITU	10.54	7.19	2.42	NCI/M2	LASL77

2027	ZR95	1977	INSITU	10.28	4.20	2.48	NCI/M2	LASL77
2153	ZR95	1977	INSITU	3.94	4.88	1.46	NCI/M2	LASL77
2090	ZR95	1977	INSITU	13.85	7.69	5.81	NCI/M2	LASL77
2099	ZR95	1977	INSITU	11.12	10.93	2.01	NCI/M2	LASL77
2031	ZR95	1977	INSITU	10.41	4.28	2.59	NCI/M2	LASL77
2082	ZR95	1977	INSITU	11.62	7.18	4.17	NCI/M2	LASL77
2043	ZR95	1977	INSITU	3.91	3.49	0.00	NCI/M2	LASL77
2126	ZR95	1977	INSITU	12.45	4.27	2.29	NCI/M2	LASL77
2148	ZR95	1977	INSITU	2.98	3.62	2.45	NCI/M2	LASL77
2062	ZR95	1977	INSITU	9.83	5.10	0.00	NCI/M2	LASL77
2008	ZR95	1977	INSITU	7.40	2.10	3.42	NCI/M2	LASL77
2131	ZR95	1977	INSITU	6.62	1.87	1.55	NCI/M2	LASL77
2014	ZR95	1977	INSITU	7.37	2.22	2.89	NCI/M2	LASL77
2135	ZR95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2055	ZR95	1977	INSITU	11.35	5.85	1.93	NCI/M2	LASL77
2050	ZR95	1977	INSITU	11.11	5.55	0.00	NCI/M2	LASL77
2116	ZR95	1977	INSITU	13.74	6.12	3.13	NCI/M2	LASL77
2142	ZR95	1977	INSITU	6.27	.00	1.52	NCI/M2	LASL77
2084	ZR95	1977	INSITU	12.58	7.17	2.94	NCI/M2	LASL77
2058	ZR95	1977	INSITU	10.00	5.31	2.77	NCI/M2	LASL77
2139	ZR95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2032	ZR95	1977	INSITU	3.17	3.48	2.04	NCI/M2	LASL77
2085	ZR95	1977	INSITU	12.60	6.58	4.64	NCI/M2	LASL77
2009	ZR95	1977	INSITU	6.59	1.65	2.83	NCI/M2	LASL77
1998	ZR95	1977	INSITU	6.63	.55	3.27	NCI/M2	LASL77
2146	ZR95	1977	INSITU	9.82	4.27	1.69	NCI/M2	LASL77
2132	ZR95	1977	INSITU	6.70	2.16	0.00	NCI/M2	LASL77
2041	ZR95	1977	INSITU	9.61	4.32	3.31	NCI/M2	LASL77
2006	ZR95	1977	INSITU	7.07	2.04	4.79	NCI/M2	LASL77
2141	ZR95	1977	INSITU	6.58	.55	0.00	NCI/M2	LASL77
2066	ZR95	1977	INSITU	10.60	4.42	3.04	NCI/M2	LASL77
2020	ZR95	1977	INSITU	3.17	3.48	0.00	NCI/M2	LASL77
2048	ZR95	1977	INSITU	11.09	5.87	2.48	NCI/M2	LASL77
2007	ZR95	1977	INSITU	7.10	2.07	1.92	NCI/M2	LASL77
2115	ZR95	1977	INSITU	13.57	6.49	3.16	NCI/M2	LASL77
2120	ZR95	1977	INSITU	14.30	7.16	0.00	NCI/M2	LASL77
2030	ZR95	1977	INSITU	10.39	4.30	3.47	NCI/M2	LASL77
2053	ZR95	1977	INSITU	10.69	5.56	3.09	NCI/M2	LASL77
2079	ZR95	1977	INSITU	10.53	7.20	2.44	NCI/M2	LASL77
2071	ZR95	1977	INSITU	9.83	4.48	3.83	NCI/M2	LASL77
2049	ZR95	1977	SG	11.11	5.55	2.53	PCI/GM	LLL GELI
2007	ZR95	1977	SK	7.10	2.07	3.63	PCI/GM	LLL GELI
1987	ZR95	1977	SK	6.63	.55	.80	PCI/GM	LLL GELI
2045	ZR95	1977	SK	10.52	5.51	2.45	PCI/GM	LLL GELI
1991	ZR95	1977	SK	6.63	.55	.90	PCI/GM	LLL GELI
2016	ZR95	1977	SK	7.24	2.33	3.50	PCI/GM	LLL GELI
2028	ZR95	1977	TH	10.37	4.33	1.24	PCI/GM	LLL GELI
2052	ZR95	1977	UK	11.11	5.55	1.59	PCI/GM	LLL GELI

APPENDIX B

LOG OF FIELD OPERATIONS FOR SURVEY OF TRINITY, 1977

During the survey of the Trinity fallout zone, each sample location was marked with a wooden stake with a brass tag attached. The number corresponding to the data "tag word" was stamped on the brass tag. The locations were noted on topographical maps of the area and in field notebooks. These documents will be kept in a master file with the Los Alamos National Laboratory Environmental Surveillance Group. Tag words that are not in the following list represent calibration checks or measurements at locations outside the Trinity fallout zone.

1985 6/20/77; background spectrum taken with planar Ge(Li) at Los Alamos National Laboratory control plot ~3 miles south of GZ.

1986 6/20/77; inside GZ inner fence. Planar Ge(Li).

1987 6/20/77; inside GZ inner fence, 13 m from fence northeast of monument. Planar Ge(Li).

1988 6/20/77; inside GZ inner fence, 7 m north of the monument. Planar Ge(Li).

1989 6/20/77; inside GZ inner fence, 10 m from fence east of the monument. Planar Ge(Li).

1990 6/21/77; outside of inner fence at GZ, 12 m south of east outhouses. Planar Ge(Li).

1991 6/21/77; outside of the inner fence at GZ. Located east of entrance road, 13 m north of the gate. Planar Ge(Li).

1992 6/21/77; located at Los Alamos National Laboratory GZ study plot, 1 mile north of fence. Taken at west side of the plot near the stake, 20 m southeast of bunkers, 80 m southwest of Bagnold sampler. Planar Ge(Li).

1993 6/22/77; near EPA No. 12117 (Beck Site). Planar Ge(Li).

1994 6/27/77; control site, 3 miles south of GZ. V-8 Ge(Li) set up over stake at southeast corner of plot.

1995 6/27/77; at northwest corner of plot, 1 mile north of GZ. Same location as No. 1992.

1996 6/27/77; taken at end of a playa north and west of GZ.

1997 6/27/77; 1 mile north of Beck Site. Same as No. 1993.

1998 6/28/77; 23 m inside gate at outer fence at GZ and 16 m of barbed wire fence along roadway.

1999 6/28/77; corresponds to location at tag word No. 1991.

2000 6/28/77; inside inner fence, 10 m north of gate. Close to No. 1986 location.

2001 6/28/77; inside inner fence; 7 m north of the monument.

2002 6/28/77; inside inner fence, 8 m west of fence on east side of the monument.

2003 6/28/77; inside inner fence, 13 m from fence north northeast of the monument. Same as No. 1987 location.

2004 6/28/77; 1 mile south of outer gate of GZ, 100 m west of roadway.

2005 6/29/77; several miles east of Mine Site, about 8-10 miles northeast of GZ. See page 17 of Trinity Field log book for sketch.

2006 6/29/77; near WSMR radar site, close to No. 2005.

2007 6/29/77; east of Nos. 2005 and 2006 in a drainage basin.

2008 6/29/77; 1.4 miles west of No. 2007.

2009 2/29/79; taken in a watering pond 0.7 mile south of Mine Site, which collects sediment from areas to the east.

2010 6/29/77; located at southwest corner of Los Alamos National Laboratory Area 16 study plot.

2011 6/30/77; located at southeast corner of Los Alamos National Laboratory Control Plot 3 miles south of GZ Same location as No. 1994.

2012 6/30/77; located 1 mile east of Junction of Beck Site Road and WSMR, Route 13 and ~50 miles north of road.

2013 6/30/77; located 4.1 miles by road from Beck Site Road/Route 13 Junction. Sample site is 1.7 miles north of the point where the road turns north and is ~30 miles west of road.

2014 6/30/77; located in bottom of Smith Tank (larger tank to the west); 6.4 miles by road from Beck Site Road/Route 13 Junction and 2.3 miles from No. 2013.

2015 6/30/77; located at the crest of a ridge 0.3 mile north of Smith Tank.

2016 6/30/77; located 0.4 mile west of fence around Smith Ranch buildings along old road, then 0.2 mile north of road at east edge of an old playa collecting sediment from the east.

2017 6/30/77; located ~0.4 mile west of No. 2016 at the west edge of the same playa.

2018 7/4/77; 6 miles north of outer fence of GZ about 30 m to the east of road.

2019 7/4/77; 8-9 miles north of GZ fence, ~30 m east of a telephone right of way.

2020 7/4/77; located 20 miles south of Hwy 380 in a large arroyo. The arroyo is 2.5 miles east of San Antonio.

2021 7/5/77; located above Area 21 study plot at a large black water tower. Same location as No. 2146.

2022 7/5/77; 12 m south of Meteorological Station at Area 21 study plot on ridge.

2023 7/5/77; on USGS "Broken Back Crater" 15 min quadrangle: R.1E.; T.4S. Section 10, 600 m south of 1919 m elevation marker. In basin.

2024 7/5/77; ~0.3 mile east and south of Hinkle Range Headquarters, 0.1 mile east of main highway on dirt access road. Adjacent to large drainage.

2025 7/6/77; 0.7 mile past turnoff to Area 21 study plot on top of a saddle, 30 miles north of the road.

2026 7/6/77; past No. 2025 east to first cattle guard, then south ~0.6 mile to a point where the drainage basin begins to narrow.

2027 7/6/77; ~1.5 to 2 miles east of a gas pump house on the north. Sample site is on a knoll east of a large basin 0.2 mile south of the main road.

2028 7/6/77; ~0.5 mile east of No. 2027 and 0.3 mile south of the highway in a closed basin.

2029 7/6/77; same as No. 2028 but 60 m farther south next to water hole.

2030 7/6/77; 150 m northeast of No. 2028 in same sediment basin.

2031 7/6/77; same sediment basin as in No. 2028 but up on a slope leading to the basin. Severe sheet erosion.

2032 7/7/77; ~10 miles south of Hwy 380, ~0.3 mile east of Rio Grande, in dirt tank.

2033 7/7/77; 100 m north of Hwy 380 at bridge over Rio Grande. Detector set up 10 m into river bed.

2034 7/7/77; located on a flood plain on east bank of the Rio Grande, 0.25 mile north from bridge.

2037 7/12/77; below Area 21 at water bank in basin, ~0.5 mile off main road and 150 m west of the large dirt tank.

2038 7/12/77; located at the northeast corner of Area 21 study plot.

2039 7/12/77; located at the northwest corner of the Area 21 study plot.

2040 7/12/77; located at the southwest corner of the Area 21 study plot.

2041 7/12/77; located at the southeast corner of the Area 21 study plot.

2042 7/12/77; located 100 m west of No. 2037 at dirt tank below Area 21.

2045 7/13/77; located 90 m north of 20° west of garage at Copeland Ranch.

2046 7/13/77; 1 mile south of EPA No. 151 at a windmill. Also, at a section corner 1 mile north and 3 miles east of Copeland Ranch.

2047 7/13/77; replicate of No. 2046, but 100 m northeast.

2048 7/13/77; located at EPA No. 151.

2049 7/14/77; located on the shoulder of a large enclosed watershed. Located at the depression and tank in Section 24 R.8E., T.25, of "Cat Mesa" USGS quadrangle.

2050 7/14/77; 100 m east of No. 2049 on shoulder. Replicate.

2051 7/14/77; located in bottom of depression 100 m east of the water tank. Same depression as Nos. 2049 and 2050.

2052 7/14/77; replicate of No. 2051, 100 m north and 45 m east of No. 2051.

2053 7/14/77; located on a ridge top 1 mile north and 0.7 mile east of Copeland Ranch.

2054 7/14/77; 100 m north of No. 2045. Replicate.

2055 7/14/77; 4.5 miles east of Copeland Ranch turnoff, 16 miles south of the road in a wide, low area.

2057 7/18/77; located ~100 m from Monte Puerto Ranch headquarters, north 65° west to front door of house.

2058 7/18/77; located ~1.5 miles south of Monte Puerto Ranch past Bench Mark, then 0.2 mile south of road in open, grassy basin.

2059 7/18/77; located at Mesa Well on Monte Puerto Ranch, north of the windmill ~200 m.

2060 7/18/77; located at a dirt tank called South Pothole on the Monte Puerto Ranch, at middle of sediment accumulation.

2061 7/18/77; replicate of No. 2060.

2062 7/18/77; 100 m from fence gate at Pothole.

2064 7/19/77; ~0.25 mile south of paved road No. 14. This is the Gran Quivira control site and is ~10 m west of the road just south of the Gran Quivira service road.

2065 7/19/77; located on Cat Mesa 20 m east of road, 0.1 miles south of Bench Mark 6239.

2066 7/19/77; located 1.3 miles east of Rugh Well just south of Maxwell Ranch headquarters, 20 m west of road near junction of several major drainages off Cat Mesa.

2067 7/19/77; located 2.25 miles south and 1.1 miles west of Mesa Well on the Monte Puerto Ranch.

2068 7/19/77; located 0.2 mile north of No. 2067 on a ridge.

2069 7/19/77; located 1.2 miles east of Line Tank on the Monte Puerto Ranch, 0.1 mile east of USGS Bench Mark 6213.

2071 7/20/77; ridge north of Cuate Tank on Hinkle Ranch.

2072 7/20/77; located in flat, grassy sediment trap at Cuate Tank on Hinkle Ranch.

2073 7/20/77; replicate of No. 2072, located 100 m east of No. 2072.

2074 7/20/77; located 1 mile south of Cuate Tank on south facing slope.

2075 7/20/77; cabin in the "Y" of the road.

2076 7/20/77; located near a water tank 3.25 miles east of Maxwell Ranch turnoff, ~0.25 mile south of road.

2077 7/20/77; located at intersection of NM 14 and road to Lovelace/Maxwell Ranches.

2079 7/21/79; control site, same as No. 2064.

2080 7/21/77; located on NM 14, 2 miles east of pavement past Gran Quivira.

2081 7/21/77; located on NM 14, 4 miles east of pavement past Gran Quivira.

2082 7/21/77; located on NM 14, 6 miles east of pavement past Gran Quivira, 100 m south past place where road turns toward Claunch.

2083 7/21/77; located on Forest Road 167, 3.5 miles east of NM 14, 20 m south of road.

2084 7/21/77; located at the junction of Forest Road 167 and Forest Road 161.

2085 7/21/77; located 3 miles south of Forest Road 167 on Forest Road 161. Site is at the intersection with a road from NM 14 going to the Surrat Ranch.

2086 7/25/77; Gran Quivira control site.

2087 7/25/77; located near the intersection of SR 14 and the road to the Atkinson Ranch, T.1.N; R.10.E, Sec. 23 at northeast side of Forest Road 167 and Forest Road 137 je..

2088 7/25/77; located 2 miles east of No. 2087, 10 m north of the road.

2090 7/26/77; located 7.25 miles west of SR 42 on Forest Road 167. Located north of the road near an occupied ranch.

2090 7/26/77; located just east of the intersection of Forest Road 167 and NM 42 at location of EPA No. 19.

2092 7/26/77; located about 6 miles northwest of Cedarvale on NM 42 at southwest side of roadside rest area.

2093 7/27/77; located ~1.5 miles southeast of Cedarvale near aircraft radio beacon at "Corona Airport."

2094 7/27/77; located on north-south road to Piños Wells in an arroyo upstream to a cattle tank, T.2.N; R.12.E.

2095 7/27/77; same as No. 2094, but moved up to nearest bench to the north above arroyo bottom.

2096 7/27/77; same as No. 2094, but moved up to nearest bench to the south above the arroyo bottom.

2097 7/27/77; located in Salt Lake basin (southern extreme) R.13.E; T.2.N.

2099 7/28/77; located near the junction of NM 42 and the ERDA Solar Irrigation Project turnoff, close to EPA No. 24.

2100 7/28/77; located about 22 miles east of Willard on U.S. 60. Located on high ground, that is, slight rise.

2101 7/28/77; located about 15 miles north of Encino on U.S. 285 on east side of road on east ridge of Pedernal Mountain.

2102 to 2113 were locations around Los Alamos used for TA-45, Bayo Canyon, Acid Canyon, and Pueblo Canyon Resurvey.

2114 8/8/77; Gran Quivira control site.

2115 8/8/77; located at junction of Forest Roads 99 and 161, 10 miles west of NM 54. Sample site is on the northeast side of the "T" intersection and 30 m north of Forest Road 161 and 30 m east of Forest Road 99.

2116 8/8/77; located ~2.3 miles east of No. 2115 on Forest Road 161. Site is in a medium-sized arroyo 40 m north of road.

2118 8/9/77; located 5.5 miles west of Corona, 2.5 miles west on Forest Road 141 to "Primitive Road" sign on south side of road, 30 m west of sign.

2119 8/9/77; located in a saddle ~0.5 mile southeast of North Peak, 0.7 mile east of Forest Road 104 on a "two-rut" road.

2120 8/9/77; located in a large stream channel just east of Forest Road 140. Site is at the confluence of a side stream with the main channel, 40 m east of Forest Road 140 and just above a newly constructed dirt tank.

2121 8/9/77; located on Gallinas Peak ~10 m north of Forest Road 102 at a small jeep trail. Site is on the leeward slope (north).

2122 8/9/77; Replicate of 2121, 200 m east.

2123 8/9/77; located near the intersection of Forest Roads 99 and 102 on Forest Road 102, 50-75 m west of Forest Road 99, 10 m south of road.

2125 8/10/77; located 3 miles east of NM 54 on the Bond Ranch. Site is 40 m south of the road in grassy stream bottom.

2126 8/10/77; located 17.2 miles west of NM 54, past Harvey Ranch.

2127 7/10/77; located near the windmill at the Erramouspe Ranch.

2128 8/10/77; located ~0.5 mile north of the Erramouspe Ranch, 15 m from dirt tank.

2129 10/4/77; located at southeast corner of the GZ control plot. Same as Nos. 1985 and 1994.

2130 10/5/77; located ~2 miles west of fence at GZ along WSMR No. 20. Site is 150 m north of road on a playa.

2131 10/5/77; 5.5 to 6 miles north of GZ. Fence at right-hand bend in the road, 50 m west of apex of turn.

2132 10/5/77; located near mine site on WSMR. Site is ~60 m southwest of the white dome.

2133 10/5/77; recount of No. 1998 inside the outer fence at GZ.

2134 10/5/77; inside inner GZ fence and the right, ~10 m inside gate.

2135 10/5/77; inside inner GZ fence, north of the monument and 7 m from fence.

2136 10/5/77; inside inner fence, 10 m west of wooden cover.

2138 10/5/77; located on WSMR midway from Route 7 to mine site at intersection of a road leading south.

2139 10/6/77; within outer fence at GZ, from gate, 3rd fence corner in clockwise direction and 20 m toward monument.

2140 10/6/77; within outer fence at GZ. Site is at 6th fence corner clockwise and 15 m toward monument.

2141 10/6/77; within outer fence at GZ. Site is at 10th corner clockwise and 30 m toward monument.

2142 10/6/77; southeast corner of Ecology GZ control site.

2143 10/6/77; located at White Sands "Gold" road block along NM 380, ~45 m south of road.

2144 20/7/77; Gran Quivira control site.

2146 10/7/77; recount of Nos. 2021 and 1981 above Area 21 at the black water tower.

2147 10/9/77; located ~0.5 mile northeast of Bingham in large dirt tank.

2148 10/9/77; located 1.5 miles east of San Antonio along NM 380.

2153 10/11/77; located 4.6 miles past the first cattle guard after crossing Rio Grande Bridge at Escondida. This is east of the river at Socorro.

2154 10/11/77; located 7.7 miles from No. 2153 along the road. Site is east and a little south of Socorro.

2155 10/11/77; located 9.3 miles from No. 2154 near an old stone house. Site is several miles north of NM 380.

APPENDIX C

IN SITU INSTRUMENT CALIBRATION

I. CALIBRATION OF INSTRUMENT RESPONSE AND FIELD APPLICATION

Calibration of *in situ* gamma-ray spectroscopy instrument response depends on the distribution of the radionuclides of interest as a function of depth of soil. Naturally occurring radionuclides are usually uniformly distributed, but surface-deposited radionuclides such as those from the Trinity event, which have leached into the soil horizons, exhibit a distribution that is a complicated function of rainfall input, soil properties, vegetation type and density, and the like. Accordingly, soil profile sampling at certain of the *in situ* measurement locations was done, and the results extrapolated to the rest of the locations by a model to be described below.

A. Calibration of Instrument Response

The response of the closed-end, cylindrical Ge(Li) detector, placed at a fixed height of one meter above the soil, is an energy-dependent function of the angular response of the detector and the flux of unscattered photons incident at the detector per unit of soil radioactivity.

A general equation expressing this relation is

$$N_f/s = (N_o/\phi)\,(N_f/N_o)\,(\phi/s) \quad , \qquad (C\text{-}1)$$

where N_f/s is the counting rate in the photopeak per unit of soil radioactivity; No/ϕ is the number of counts in the photopeak of interest per incident photon/cm^2 for a point source at 0° from the detector's axis; N_f/N_o is an angular correction factor to account for nonuniform response at angles between 0° and 90°; and ϕ/s is the theoretical flux of unscattered photons incident at the detector per unit of soil activity. Normally, calibration involves a calculational procedure independent of the geometries of the distributed sources to be evaluated. Radionuclides that have been redistributed through the vertical profile from an initial surface deposition are usually assumed to be exponentially distributed. As a crosscheck of the laboratory calibration and suitability of the soil sampling for estimation of vertical distribution, an empirical calibration was attempted as well.

The coefficient $N_f/\phi = (N_o/\phi)(N_f/N_o)$ (that is, the product of the first two terms on the right) represents the total detector registration efficiency for unscattered photons under field conditions. It is a function of the energy and distribution of unscattered photons. The unscattered photon distribution itself is a function of photon energy, source activity distribution vertically and over area, detector height, and the mass attenuation coefficients and densities of soil and air. The source activity distribution and photon energy are the most important parameters. Small variations in the other parameters result in only minor variations in the coefficient N_f/ϕ. In Appendix D, it is shown that an independent determination of this coefficient based on measured instrument response and a source term developed from measured vertical profiles of ^{137}Cs activity fitted to an exponential distribution function provides an empirical estimate of detector efficiency, which compares very well with the laboratory calibration performed at Lawrence Livermore National Laboratory (LLNL).

B. Field Applications

The gross, short-term stability of the total spectrometer as well as long-term stability under the stresses of a rather severe environment typical of the New Mexico desert during the summer months were both concerns during field operations.

The gross response of the system was checked at the beginning of each day and at regular intervals during the day by counting a small calibration source placed directly under the detector. As a check of long-term stability, two control plots were selected as convenient background locations that could be repeatedly counted during the course of the field work. One was an intensive study area about 1 mile south of the Trinity event GZ site on the

White Sands Missile Range; the other was near the Gran Quivira National Park in the vicinity of Chupadera Mesa.

II. EVALUATIONS OF TRINITY ^{137}Cs DATA

As a result of the present Trinity resurvey, there are two basic sources of raw data on ^{137}Cs concentrations in soils and biota in the Trinity fallout field: the measurements made on canned samples submitted to LLNL for analysis, and the *in situ* Ge(Li) spectral data. For most of the *in situ* locations, field integration of the cesium peak was made by a reliable approximation technique. These field data and the results of the laboratory measurements of canned samples provided the basis for the preliminary evaluations described in the following discussion.

An essential factor for purposes of estimating the total inventory of ^{137}Cs in the soil is the reciprocal of the exponential relaxation depth of contaminant in the soil profile (α). Only nine sample locations on Chupadera Mesa yielded profile concentration data usable for estimating the profile distribution. Of these, three were estimates based on data for the first and third 5-cm profiles only, which would tend to make the estimated profile parameters less reliable. Overall, there is uncertainty in the estimates of α from the soil data because of the way samples were collected and analyzed, as well as the natural variability in the distribution from place to place in the vicinity of the *in situ* measurement. Estimates of α were generated from the soil profile data using standard least-squares regression techniques.

In order to extend this profile data set to the remainder of the sample locations on the mesa, it was determined by multiple regression studies that a useful predictor could be developed from data on the elevation of each sample location and position on the local topological sequence (reduced to simply ridge top, side slope, or depression). The topological sequence information was made quantitative by means of a linear compartment model of ^{137}Cs redistribution during the past 30 years among these topological sequences on the mesa. The regression relationship derived accounts for 76% of the variability in the data, which, considering the many sources of variability in ^{137}Cs redistribution through the soil profile, seem remarkably good. Predicted reciprocal relaxation depths ranged from 0.1 cm^{-1} to 1.2 cm^{-1}, with the higher values (corresponding to shallower distributions) predicted for highest elevations. For simplicity in computer processing the field Ge(Li) spectrometer data, these predicted values were reduced to one of four values of α, uniform (α=0), 0.2, 0.4, or 0.7. Sample locations off Chupadera Mesa were assigned α values based on judgment and on limited distribution data when available. Ground Zero areas were found to exhibit nearly uniform profiles, while intervening regions had profiles typical of worldwide fallout (relaxation depth of 5 cm).

The response of a bare Ge(Li) detector to the inventory of gamma-emitting radionuclides in the soil over which it is placed is dependent on detector-source geometry, photon energy, and the vertical distribution of activity (characterized by the α-parameter). Usually the detector is calibrated for photon energy and geometry dependence by the use of sealed sources, while the α-dependence is accounted for theoretically. (See Chapter 2 for details on standard calibration techniques.) The *in situ* calibration efficiency term, N_f/s, is defined for sealed source calibration by an energy-dependent zero-angle response term, N_f/ϕ, an angular correction (geometry) term N_f/N_o, and an α-dependent source term ϕ/s:

$$N_f/s = (N_o/\phi)(N_f/N_o)(\phi/s) \quad ,$$

where

N_f/s = count rate in photopeak/unit of soil activity (nCi/m^2),

N_o/ϕ = counts per min per incident photon/cm^2 at the detector for a source at 0° from detector axis,

N_f/s = angular correction term, and

ϕ/s = flux of unscattered photons incident at the detector per unit of soil activity.

However, the *in situ* efficiency can also be estimated from field data. In fact, an independent check of the suitability of the relatively weakly determined profile parameter for estimating total profile inventory, α, can be made by an independent determination of the efficiency of the detector, N_f/s, from a set of field data. The flux per unit source, ϕ/s, is determined mathematically as a function of α. The count rate in the photopeak of ^{137}Cs was field-integrated, yielding an estimate of N_f at each location. "S" can be approximated under the assumption that the ^{137}Cs activity is exponentially distributed in the soil profile by integrating the exponential distribution:

$$S = S_o \int_o^{\alpha} e^{-\alpha x} \, dx = \frac{S_o}{\alpha} \quad , \qquad \text{(C-3)}$$

where

S_o = approximate activity in the top layer of soil, nCi/m², and

α = reciprocal of relaxation depth, cm^{-1}.

S_o can be approximated from the measured ^{137}Cs concentration at each location where profile data are available with which to estimate α. These parameters suffice to determine a lumped parameter, N_f/ϕ, which, when multiplied by ϕ/S, yields an estimate of the calibration factor, N_f/S. The theoretical relation between ϕ/S and α is shown in Fig. C-1. The product of ϕ/S and the estimated S for each measured α divided into N_f yields estimates of

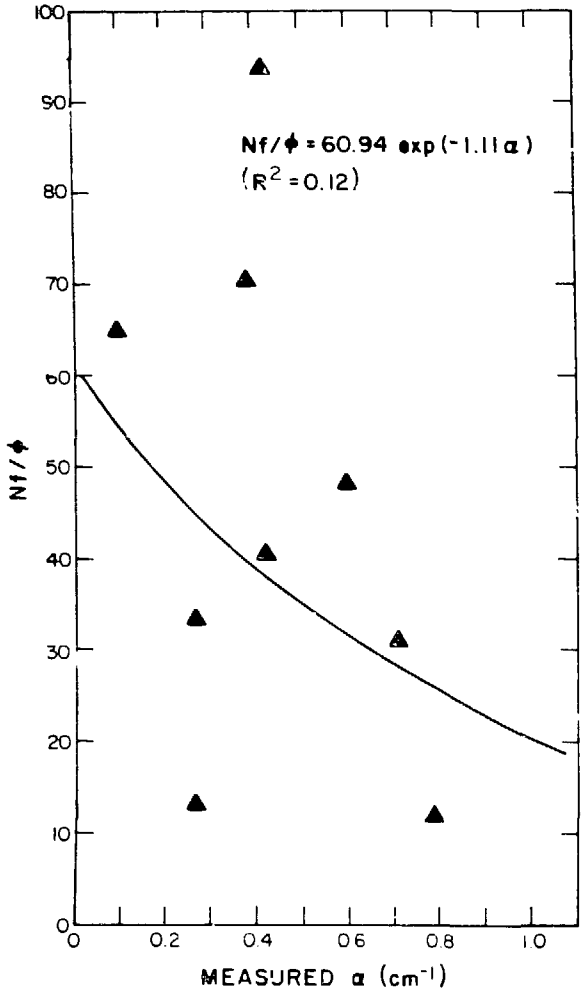

Fig. C-1. N_f/ϕ as a function of α.

N_f/ϕ as a function of α. These values are tabulated in Table C-I. In Fig. C-2, these data are fitted to an exponential curve using standard regression techniques. The low coefficient of determination (R^2 = 0.12) is indicative of the large variability in the data, and hence the somewhat arbitrary choice of an exponential fit to the data. The predicted calibration term $N_f/s = (N_f/\phi)(\phi/s)$ is plotted in Fig. C-2.

III. STATISTICAL CONSIDERATIONS OF MINIMUM DETECTABLE ACTIVITY OF ^{137}Cs AND $^{239,240}Pu$

In the Trinity resurvey project there were several types of radioactivity measurements made with a variety of equipment and techniques. Results are reported as activity per gram or per square meter. The sensitivity and precision of a given instrumentation and method depends on such parameters as detection efficiency, energy resolution, and background levels. In addition, sample volume, available counting time, and degree of statistical precision required are crucial determinants. Following the approach of Walford and Gilboy,[C1] and Kirby,[C2] an expression can be derived what will enable an estimation of sensitivity limits (or minimal detectable activity) in terms of zone of these parameters.

It was assumed that whether ^{137}Cs or ^{239}Pu was being measured, the detection system utilized possessed an energy resolution capability such that radionuclide-specific counts (for example, counts in a photopeak) were identifiable while situated on a background continuum. In this context, precision of the count is definable in terms of the coefficient of variation c, where c = standard deviation of the net peak counts/net peak counts. If S is the measured peak plus background counts within the channel defining the peak and B and D are the background and peak counts in this region, all measured for a time T, then

$$S = D + B \quad . \tag{C-4}$$

For a highly stable counting system, variation is principally from counting statistics in both the peak channels $(s = B)^{1/2}$ and in the statistical variation in the data on either side, giving rise to an additional variance V. The coefficient of variation can be written in these terms as

$$C = \frac{(D + 2B + V)^{1/2}}{D} \quad . \tag{C-5}$$

TABLE C-I

COUNT RATE PER UNIT FLUX AT THE DETECTOR, N_f/ϕ, AS A FUNCTION OF MEASURED α

Sample No.	Measured α (cm^{-1})	Inventory S (nCi/m^2)	Measured N_f	Flux ϕ	N_f/ϕ
2027	0.27	187.5	111.22	3.28	33.89
2045	0.27	68.8	15.76	1.2	13.09
2048	0.43	39.7	81.81	0.87	93.69
2058	0.42	193.7	170.37	4.20	40.53
2071	0.39	126.8	187.0	2.66	70.27
2080	0.10	51.1	29.6	0.46	65.06
2115	0.71	66.1	56.37	1.82	31.01
2118	0.60	54.6	69.02	1.42	48.63
2120	0.79	252.7	88.05	7.33	12.02

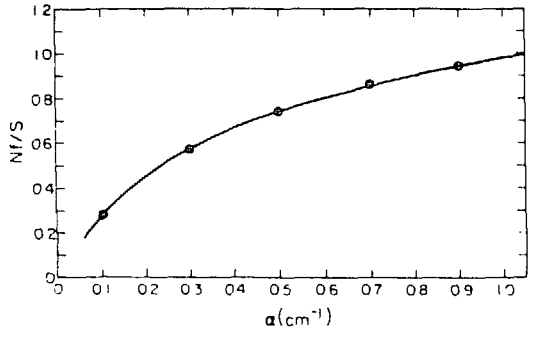

Fig. C-2. $N_f/s = N_f/\phi \cdot \phi/s$ as a function of α.

Solving for D yields

$$D = \frac{\{1 + [1 + 4C^2(2B + V)]^{1/2}\}}{2C^2} \quad . \qquad (C\text{-}6)$$

The total count in a peak is a product of the detector peak efficiency, N_f/S, which is the count rate in the peak per unit activity in the ground S, the time of the count T, and the activity in the ground S_A

$$D = (N_f/S)(T)(S_A) \quad . \qquad (C\text{-}7)$$

The minimal detectable level of activity (minimum S_A) is, thus, from Eqs. (C-6) and (C-7)

$$S_{min} = \frac{1}{2C^2(N_f/s)T}\{1 + [1 + 4C^2(2B + V)]^{1/2}\} \quad . \qquad (C\text{-}8)$$

Since the variance in the net peak counts, VAR(D), is the square of the numerator of Eq. (C-5), the quantity (2B + V) in Eq. (C-8) can be replaced by the equivalent VAR(D) - D. This permutation allows calculation of the minimum detectable activity without introducing the specific background count. The *in situ* and laboratory Ge(Li) data are reported only in terms of peak count rate and standard deviation or fractional standard deviation.

If the criterion of acceptability is that the coefficient of variation be no larger than 0.3 for a typical count time of 2000 s (33.3 min), then S_{min} becomes

$$S_{min} = \frac{0.167}{N_f/s}\{1 + [1 + 0.36(VAR(D)]^{1/2}\} \quad . \qquad (C\text{-}9)$$

For the known peak count, R, and the fractional standard deviation of the peak count rate, σ_{cpm}, S_{min} becomes

$$S_{min} = \frac{0.167}{N_f/s}\{1 + [1 + 400(\sigma_{cpm}R^2 - 0/03R)]^{1/2}\} \quad . \qquad (C\text{-}10)$$

REFERENCES

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C2. J. A. Kirby, L. R. Anspaugh, P. L. Phelps, G. A. Armantrout, and D. Sawyer, "A Detector System for *In Situ* Spectrometric Analysis of ^{241}Am and Pu in Soil," *IEEE Transactions on Nuclear Science* (February 1976).

APPENDIX D

INTERPRETATION OF DATA

This appendix provides the information and assumptions used to calculate the doses from the current conditions at Trinity Site and the fallout zone to the northeast including Chupadera Mesa. The land uses in the area include the restricted area of White Sands Missile Range, grazing of cattle, and a few crops grown in the far fallout areas. Chupadera Mesa is all grazing with ranches ranging in size from 100 square miles to some exceeding 200 square miles. Home gardening is practiced with irrigation water being supplied from wells. Well water samples did not contain any significant amounts of the fallout radionuclides now remaining in the area.

I. SOILS DATA BY AREA

A. Background Levels of Radionuclides and Radiation

Reference values for background concentrations of radioactivity in soils and sediments attributable to natural constituents or general worldwide fallout were assembled from several studies to provide a basis for comparison (Refs. D1, D2, D3, and D4). This information is summarized in Table D-1. Most of the data were from a compilation on soils and sediments collected in northern New Mexico over the period 1974-1977 as part of the Los Alamos National Laboratory routine environmental surveillance program. Some of the data were taken from other studies representing generally smaller numbers of samples.

The data in Table D-1 can be used only as a general comparison for the data taken for Trinity fallout zone. The distribution of worldwide fallout radionuclides varies with latitude and longitude in the U.S. However, the data for northern New Mexico are the only compilation available for this area of the U.S.

B. Survey Sample Results

1. Trinity Site GZ Area. Measurements of the radiation present at GZ of Trinity Site were started very early. On July 16, 1945, measurements at 30 000 feet to the north of GZ recorded 10 R/h, while 30 000 feet to the west only 0.2 R/h was recorded (Ref. D5). At 12 000 feet south of GZ, nothing was recorded. At 4500 feet south, 0.011 R/h was recorded. At 6:30 p.m. on July 16, 1945, a measurement 30 feet west of GZ recorded 6000 R/h (Ref. D5). Measurements made August 12 and 14, 1945, recorded 7 R/h at GZ with a circular area around GZ reading 15 R/h (Ref. D6). In October, 1945, a number of excavations were made to study the blast effects of the test (Ref. D7).

Ground disturbances at the GZ area occurred a number of times. In 1947, the Trinitite containing the most radioactivity was placed in 12 drums and buried inside the GZ area (Ref. D8). In 1952, the removal of the top inch of earth including the remaining lower activity Trinitite was arranged (Ref. D9). In 1965 a monument was erected at the center of the GZ tower. In 1967 a detailed radiological survey was conducted to document the radiation doses present. The study detected a high of 3 mR/h and low of 0.03 mR/h within the fenced areas (Ref. D10). At the same time, the 12 drums of Trinitite were dug up with a backhoe and shipped to Los Alamos National Laboratory where disposal was accomplished in the low-level waste burial facility (Ref. D8). The 1967 study concluded there was no risk to persons visiting the site.

Visits by the public to the site currently are limited to an Army-sponsored 2-h stay time. The keys to the area are only available from the White Sands Missile Range security office and only after approval by the safety officer.

In 1977 the radiation survey for the DOE Remedial Action Programs made a few surface measurements at GZ. However, no data were taken on the depth of contamination during previous surveys. In 1983 both auger samples and split-spoon samples were obtained in the fenced areas of GZ. Figure D1 indicates the locations of the soil samples at depth as well as locations of air samples and external radiation measurements. External

TABLE D-I

NORTHERN NEW MEXICO BACKGROUND REFERENCE VALUES FOR NATURAL OR FALLOUT LEVELS OF RADIOACTIVITY

Isotope	Mean Concentration ($\bar{x} \pm s$)	Range of Concentrations	Units	No. of Samples	Comment	Reference
^{239}Pu	0.008 ± 0.010	<0.002 - 0.045	pCi/g	149	Soils and sediments 0-5 cm	D1
^{238}Pu	<0.000 ± 0.0064	<0.003 - 0.010	pCi/g	151	Soils and sediments 0-5 cm	D1
^{241}Am	0.004 ± 0.004	<0.001 - 0.009	pCi/g	7	Sediments 0-5 cm	D2
^{90}Sr	0.25 ± 0.27	<0.05 - 1.0	pCi/g	68	Soils and sediments 0-5 cm	D1
^{137}Cs	0.32 ± 0.30	<0.10 - 1.06	pCi/g	76	Soils and sediments 0-5 cm	D1
Total U	1 8 ± 1.3	<0.1 - 5.1	µg/g	118	Soils and sediments 0-5 cm	D1
^{232}Th	14.3 ± 3.6	9.2 - 20.1	µG/G	8	Soils 0-30 cm	D3
^{226}Ra	2.4 ± 0.8	1.6 - 3.9	pCi/g	7	Soil 0-5 cm	D4

radiation measurements were made with four thermoluminescent dosimeters (TLDs) at each location.

Tables D-II and D-III provide the data from soil samples for $^{239-240}Pu$ and ^{152}Eu. Samples from the GZ inner fence area exhibit $^{239-240}Pu$ levels 1.5 to 2.5 times proposed guidance levels of 100 pCi/g developed by the DOE Remedial Action Programs (Ref. D11). The quantities in the GZ samples also exceed the U.S. Environmental Protection Agency (EPA) guidance on transuranics of 0.2 µCi/m^2 for the top 1 cm of soil (Ref. D12).

Examination of the $^{239-240}Pu$ surface sample data for between the fences indicates none of the surface samples exceeds the Remedial Actions Program criteria. Table D-IV includes the means for surface samples at similar distances from GZ. None of the means exceeds either DOE or EPA proposed criteria for surface contamination. For soil samples between 1-6 cm taken between the fences, all results were below DOE and EPA proposed criteria. Below 40 cm (16 inches), all soil sample results for $^{239-240}Pu$ were the same as fallout levels in northern New Mexico.

Europium-152 is the predominant gamma-ray emitter in the soils of the GZ area. In undisturbed areas between the fences around GZ, the ^{152}Eu appeared in soil samples at deeper levels than plutonium. This would appear to suggest some mobility greater than plutonium. Also, measurements by *in situ* gamma-ray spectroscopy indicate ^{152}Eu is the major contributor to external radiation doses at GZ. There are no specified criteria for the amount of ^{152}Eu in soils. However, the DOE limits the

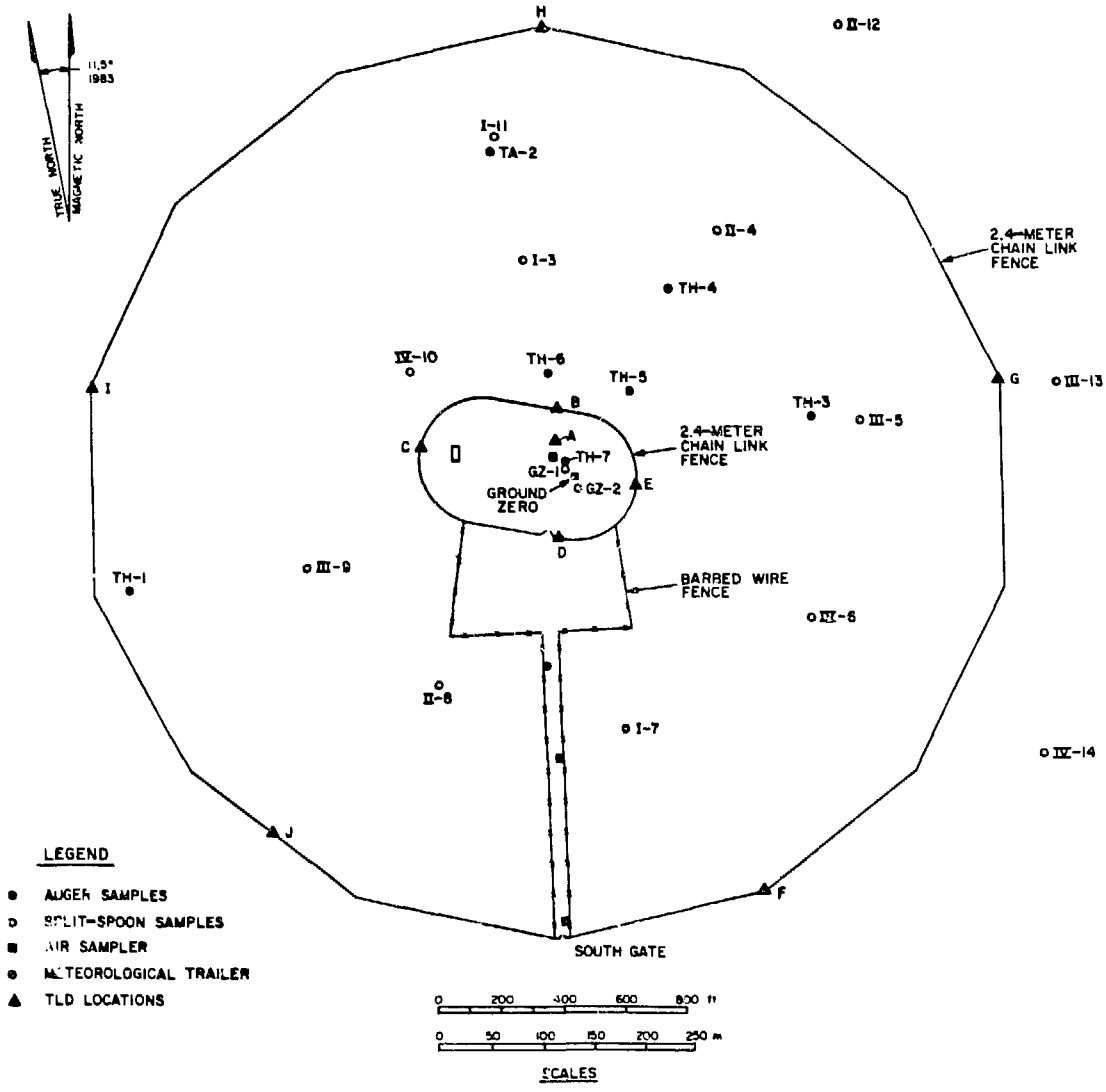

Fig. D-1. Location of June 1983 sampling.

maximum acceptable whole-body exposure to 500 mrem/yr. The annual visit allowed by the Army would result in a maximum dose of 1 mrem/yr added to about 150 mrem/yr from natural radiation for the area. The average dose per 2-h visit is likely to be about 0.5 mrem.

2. Radioactivity in Soils of Trinity Fallout Areas. Based on the soil data taken by this survey and the 1973 and 1974 survey by the U.S. EPA, the $^{239\text{-}240}$Pu arithmetic mean content of surface soils and deeper soil samples is less than criteria for removal by both the DOE and EPA. That is, the levels are considered safe for continuous residence by the public in the area. The plutonium content and content of other radionuclides from the Trinity test fallout are summarized in Tables XIV through XIX in Chapter 4. The tables are summaries of the data from Appendix A.

II. DOSE CALCULATIONS

The EPA guidance for transuranics in the general environment is based on a set of assumptions on how

TABLE D-II

1983 PLUTONIUM DATA FOR SPLIT SPOON CORE SAMPLES FROM GROUND ZERO AREA

$^{239-240}Pu$ (pCi/g)

	Sample Number and Distance from GZ					
Depth	GZ-1 (12 m)	GZ-2 (12 m)	Depth	I-3 (210 m)	II-4 (275 m)	III-5 (280 m
0-1 cm	...	22.8000 ± 0.2000	0-1 cm	20.6000 ± 0.2000	0.3100 ± 0.0200	0.9900 ± 0.0300
1-6 cm	...	156.0000 ± 15.0000	1-6 cm	...	0.1810 ± 0.0150	0.0440 ± 0.0140
0-6 in.	...	23.7000 ± 0.4000	16-22 in.	0.0056 ± 0.0010	0.0043 ± 0.0010	0.0022 ± 0.0010
6-12 in.	256.0000 ± 3.0000	...	22-28 in.	0.0029 ± 0.0010	0.0110 ± 0.0030	0.0041 ± 0.0010
12-18 in.	0.4000 ± 0.0200	...				
18-24 in.	1.3300 ± 0.0400					
24-30 in.	...	9.9000 ± 0.3000				
30-36 in.	...	0.1030 ± 0.0080				
36-42 in.	...	4.9300 ± 0.1300				
42-48 in.	...	0.1350 ± 0.0080				

Depth	IV-6 (265 m)	I-7 (250 m)	II-8 (245 m)	Depth	IV-10 (185 m)	I-11 (330 m)
0-1 cm	5.0900 ± 0.8000	0.0440 ± 0.0070	27.5000 ± 0.3000	0-1 cm	0.5600 ± 0.0300	8.5000 ± 0.1500
1-6 cm	...	0.0590 ± 0.0080	0.7300 ± 0.0400	1-6 cm	0.1570 ± 0.0150	...
				4-10 in.	0.0230 ± 0.0050	
16-22 in.	0.0021 ± 0.0010	0.0070 ± 0.0020	0.0100 ± 0.0020	16-22 in.	0.0021 ± 0.0010	0.0068 ± 0.0010
22-28 in.	0.0070 ± 0.0020	0.0160 ± 0.0030	0.0180 ± 0.0030	22-28 in.	0.0005 ± 0.0000	0.0130 ± 0.0020

Depth	II-12 (510 m)	III-13 (475 m)	IV-14 (520 m)	Depth	Control (5200 m)
0-1 cm	0.0430 ± 0.0080	0.0940 ± 0.0130	0.0410 ± 0.0090	0-1 ft	0.0019 ± 0.0010
1-6 cm	0.0410 ± 0.0100	0.1500 ± 0.0200	0.0190 ± 0.0060	1-2 ft	0.0006 ± 0.0000
16-22 in.	0.0110 ± 0.0020	0.0025 ± 0.0010	0.0047 ± 0.0010	2-3 ft	0.0024 ± 0.0010
22-28 in.	0.0038 ± 0.0010	0.0091 ± 0.0010	0.0040 ± 0.0010	3-4 ft	0.0011 ± 0.0000

TABLE D-III

1983 ^{152}Eu DATA FROM SPLIT SPOON CORE SAMPLES IN GROUND ZERO AREA

^{152}Eu (pCi/g)

Sample Number and Distance from GZ						
Depth	GZ-1 (10 m)	GZ-2 (12 m)	Depth	I-3 (210 m)	II-4 (275)	III-5 (280 m)
0-1 cm	---	284.3388 ± 29.0322	0-1 cm	33.6445 ± 3.5359	13.3744 ± 1.7159	9.9419 ± 1.3869
1-6 cm	---	245.4959 ± 24.9538	1 6 cm	30.8438 ± 3.4902	10.5350 ± 1.2412	10.0096 ± 1.4444
0-6 in.	500.7191 ± 50.6747	264.5681 ± 26.8594	4-10 in.	14.7625 ± 1.6236	5.4157 ± 0.9014	5.3234 ± 0.8980
6-12 in.	1069.0675 ± 107.7231	957.6400 ± 96.2607	10-16 in.	5.7801 ± 0.6222	0.8868 ± 0.7104	2.2046 ± 0.2800
12-18 in.	282.0225 ± 28.3633	169.0552 ± 17.4506	16-22 in.	0.9959 ± 0.1526	0.5379 ± 0.2188	0.7792 ± 0.2400
18-24 in.	40.1567 ± 4.0812	222.9221 ± 22.4308	22-28 in.	0.8026 ± 0.1551	0.2654 ± 0.1115	0.3642 ± 0.1086
24-30 in.	22.5086 ± 2.2929	129.8201 ± 13.0731	28-34 in.	1.4461 ± 0.2819	---	---
30-36 in.	0.5566 ± 0.1335	24.1423 ± 2.4623	34-40 in.	0.0415 ± 0.1552	---	---
36-42 in.	1.0331 ± 0.1636	10.4316 ± 1.0858	40-46 in.	0.1950 ± 0.1169	---	---
42-48 in.	0.4203 ± 0.1278	3.9016 ± 0.4443	46-52 in.	0.3665 ± 0.1436	---	---

Depth	IV-6 (265 m)	I-7 (230 m)	IV-10 (185 m)	Depth	I-11 (330 m)	II-12 (510 m)	III-13 (475 m)
0-1 cm	13.8847 ± 1.6654	3.4109 ± 0.3888	58.6909 ± 6.1822	0-1 cm	5.1252 ± 1.0778	1.3496 ± 0.6956	0.0760 ± 0.2515
1 6 cm	16.9154 ± 2.0174	4.5362 ± 1.1405	46.1493 ± 4.8400	1-6 cm	3.5483 ± 0.9248	1.1844 ± 0.5268	2.5695 ± 1.0400
4-10 in.	2.0848 ± 1.5203	2.8248 ± 0.8710	23.0370 ± 2.5576	4-10 in.	0.8999 ± 0.7806	2.1175 ± 0.5756	0.6602 ± 0.4074
10-16 in.	4.1317 ± 0.9492	0.4960 ± 0.1940	5.7562 ± 0.6522	10-16 in.	2.1553 ± 0.6975	0.6941 ± 0.4311	0.4506 ± 0.5043
16-22 in.	0.6858 ± 0.1823	0.2761 ± 0.1871	1.5456 ± 0.2405	16-22 in.	0.3492 ± 0.1666	0.4024 ± 0.1540	0.6390 ± 0.2391
22-28 in.	0.4285 ± 0.1389	0.4526 ± 0.1697	0.5428 ± 0.1321	22-28 in.	0.2080 ± 0.1061	0.2385 ± 0.2039	0.2231 ± 0.1409
28-34 in.	---	---	0.4930 ± 0.1476	---	---	---	---
34-40 in.	---	---	0.2072 ± 0.4930	---	---	---	---

Depth	IV-14 (520 m)	Depth	II-8 (245 m)	Depth	II-8c (245 m)
0-1 cm	0.6312 ± 0.5778	0-6 in.	18.2777 ± 2.2156	0-1 cm	25.0172 ± 3.0114
1-6 cm	0.1291 ± 0.4440	6-12 in.	5.2162 ± 0.9229	1-6 cm	21.0319 ± 2.7315
4-10 in.	0.5836 ± 0.2980	12-18 in.	4.1792 ± 0.1840	6-11 cm	16.4178 ± 2.1762
10-16 in.	0.1585 ± 0.5181	18-25 in.	0.2456 ± 0.1056	8-13 in.	6.7864 ± 1.0562
16-22	---	24-30 in.	0.3192 ± 0.1996	13-19 in.	2.2228 ± 0.2649
22-28 in.	0.4468 ± 0.1902	30-36 in.	0.4045 ± 0.1628	19-25 in.	0.6343 ± 0.1665
---	---	36-42 in.	0.3108 ± 0.1398	25-27-1/2 in.	0.4335 ± 0.1455

TABLE D-IV

JUNE 1983 PLUTONIUM DATA FROM TRINITY GZ AREA

Location	Sample	0–1 cm	1–6 cm	Distance from GZ
	III - 5	0.99 ± 0.03	0 044 ± 0.014	280 m
See Figure D-1	IV - 6	5.09 ± 0.8	—	265 m
	I - 7	0.044 ± 0.01	0.059 ± 0.01	250 m
	II - 8	27.5 ± 0.3	0.73 ± 0.04	245 m
	II - 4	0.31 ± 0.02	0.18 ± 0.02	275 m
		$\bar{x}$ = 6.78 ± 11.8	---	---
Outside fences	II - 12	0.043 ± 0.008	0 041 ± 0.01	510 m
Outside fences	III - 13	0.094 ± 0.013	0.15 ± 0.02	475 m
Outside fences	IV - 14	0.041 ± 0.009	0.019 ± 0.006	520 m
		$\bar{x}$ = 0.059 ± 0.03	---	---
Between fences	IV - 10	0.56 ± 0.03	0.157 ± 0.015	185 m
Between fences	I - 11	8.5 ± 0.15	8.8 ± 0.13	330 m
Mean for Between fenced area		$\bar{x}$ = 5.8 ± 9.5	---	---
3 Miles South of Entrance gate	Control site	0.0019 ± 0.001[a]		5.2 km
Ground Zero Inner fence	GZ	22.8 ± 0.2	156 ± 15	12 m
Northern New Mexico	Average	0.008 ± 0.01	---	---

[a]Data for 0-1 foot.

radionuclides reach man. The guidance only considers transuranic elements such as plu' nium. In the Trinity fallout zone, there are also residual fission products. The residual fission products are dominated by ^{137}Cs and ^{90}Sr. Thus, investigations regarding the safety of living in the fallout zone need to consider the total doses from all radionuclides present.

The doses are from three major paths to man. The external radiation doses as measured are reported in Chapter 4. The doses from inhalation and ingestion of radionuclides in air and food require calculational estimates. The following sections discuss the information used for these calculations, as well as present, intermediate, and final results.

A. Inhalation of Radionuclides

The residual contamination in the soils of the fallout zone provides a source of particulate matter that may be resuspended by wind movement or other mechanical

TABLE D-V

PARAMETERS FOR ESTIMATION OF RESUSPENSION OF RADIONUCLIDES USING MASS LOADING (24 μg/m³)[a]

Area	Effective Soil Concentration (pCi/g)				Estimated Annual Average Air Concentration (μCi/m³)			Measured $^{239,240}Pu$ (μCi/m³)
	$^{239,240}Pu$[b]	^{90}Sr	^{137}Cs	$\Sigma g_i f_i$	$^{239,240}Pu$	^{90}Sr	^{137}Cs	
Trinity Site								
Inner Fence	22.8	---	16.5	0.071	3.8×10^{-11}	---	2.8×10^{-11}	6.3×10^{-11}
Outer Fence	5.8	---	0.54	0.071	9.8×10^{-12}	---	9.2×10^{-13}	0.1×10^{-11}
White Sands	13.2[b]	1.8	4.5	0.071	2.2×10^{-11}	3×10^{-12}	1.8×10^{-12}	---
Bingham	0.36[c]	---	3.7[c]	0.78	6.7×10^{-12}	---	6.9×10^{-11}	---
Chupadera Mesa	3.2[b]	2.3	2.8	1.6	1.2×10^{-10}	8.8×10^{-11}	1.1×10^{-10}	4.1×10^{-11} [d]
Far Fallout Zone	0.57[b]	1.47	2.0	1.6	2.2×10^{-11}	5.6×10^{-11}	7.7×10^{-11}	---
San Antonio, NM	0.019[b]	---	4.8[c]	1.6	7.3×10^{-13}	---	1.8×10^{-10}	4.3×10^{-11} [d]

[a] Reference D13.

[b] For samples other than 1 cm deep, a Correction Factor Applied for profit distribution: 1.32 for White Sands, 0.34 for Bingham, 1.9 for Chupadera Mesa, Far Fallout Zone and San Antonio. See Reference D14.

[c] Estimated from *in situ* measurements.

[d] Reference D15.

action. Such airborne particulate matter could be inhaled by persons occupying the areas. Few direct measurements of total airborne radioactivity have been made in the area. Some of these results were discussed in Chapter 4. Another method of evaluating the potential contribution of resuspension of residual contamination in the areas is described here. The theoretical model selected is the straightforward mass-loading approach, which has been assessed as being suitable for conditions where the contaminant has been aged in the environment for some time (Ref. D16). Refinements to account for unequal distribution of the contaminant on different particle sizes and for the limited size of the contaminated area were included. The basic approach predicts the concentration of airborne activity (activity/unit volume of air) as the product of the mass of particulates in the air (mass/unit volume of air) and the concentration of activity in the soil (activity/unit mass of soil) in the area. This predicted air concentration is modified by an enrichment factor to account for the generally higher concentration per unit mass on smaller particles in the respirable range and for the generally small weight fraction of small particles in soils.

The various parameters and the estimated airborne concentrations of ^{239}Pu for the individual areas are summarized in Table D-V. The arithmetic mean ^{239}Pu soil concentrations came from Tables XIV through XIX.

The enrichment factors for each area where particle size and activity distribution data were available were calculated as shown in Table D-VI. The enrichment ratio g_i is the quotient of the activity fraction for a given particle size increment i and the mass fraction for that size increment. These fractions were taken from or based on actual measurements of soils in the GZ and Chupadera Mesa areas as indicated by the references in the table. The airborne mass fraction f_i for the size

TABLE D-VI

ENRICHMENT FACTORS FOR RESUSPENDABLE PARTICLES

Area	Size Increment (μm)	Wt. Fraction	^{239}Pu Activity Fraction	Activity Mass Ratio g_i	Airborne Mass Fraction f_i[d]	Enrichment $g_i f_i$	$\Sigma g_i f_i$
Trinity Site	53 - 105	0.11[a]	0.0043[a]	0.039	0.35	0.014	---
	< 53	0.089[a]	0.078[a]	0.088	0.65	0.057	0.071
White Sands	53 - 105	0.11[b]	0.0043[b]	0.039	0.35	0.014	---
	< 53	0.089[b]	0.078[b]	0.088	0.65	0.057	0.071
Bingham	53 - 105	0.19[b]	0.03[b]	0.16	0.35	0.056	---
	< 53	0.10[b]	0.11[b]	1.1	0.65	0.752	0.78
Chupadera Mesa	53 - 105	0.18[b]	0.16[b]	0.89	0.35	0.31	---
	< 53	0.36[b]	0.73[b]	2.0	0.65	1.32	1.6
Far Fallout Zone	53 - 105	0.18[c]	0.16[c]	0.89	0.35	0.31	---
	< 53	0.36[c]	0.73[c]	2.0	0.65	1.32	1.6
San Antonio	53 - 105	0.18[c]	0.16[c]	0.89	0.35	0.31	31
	< 53	0.36[c]	0.73[c]	2.0	0.65	1.32	1.6

[a]Assumed to be the same as measured at 1.6 km location northeast of GZ.
[b]Reference D14.
[c]Assumed to be the same as measured at Chupadera Mesa.
[d]Reference D13.

increment was taken from Fig. A2-3 in Ref. D13. The enrichment factor ($\Sigma_i f_i g_i$) is the sum over the size increments of the respective $f_i g_i$ products.

The annual average mass loading was taken to be 24 μg/m^3 (Ref. D16). This value is an annual geometric mean.

The estimated annual average ^{239}Pu air concentration is shown for each area. Table D-V also shows estimated annual average air concentrations for ^{90}Sr and ^{137}Cs for each area in which these isotopes occurred at concentrations on soil statistically above background as summarized in Table D-I as measurements had been made.

Potential doses that could result from the estimated air concentrations were calculated by using standard inhalation rates to determine intakes and appropriate dose conversion factors (Ref. D17). For dose estimation, the presence of transuranics other than ^{239}Pu (i.e., ^{238}Pu, ^{241}Pu, and ^{241}Am) was accounted for by using a dose factor combining the effect of aging weapons grade plutonium for 50 years (Ref. D18). Table D-VII presents a summary of the dose factors for the first year and 50-year committed dose equivalents for the isotopes and organs of interest.

TABLE D-VII

INHALATION DOSE FACTORS USED
(mrem/μCi)[a]

Radionuclides	First Year Dose			50-Year Committed Dose Equivalent			
	Whole Body	Bone	Lung	Whole Body	Bone	Lung	Liver
Plutonium isotopes[b,c]	2.3×10^2	8.3×10^3	5.3×10^4	8.7×10^4	9.0×10^5	9.4×10^5	4.5×10^5
^{90}Sr	8.3	1.9×10^2	7.0×10^2	7.6×10^2	1.2×10^4	1.2×10^3	---
^{137}Cs	3.3×10^1	3.3×10^1	5.2	5.6×10^1	6.1×10^1	9.4	---

[a]Dose factors are from References D19 and D17.
[b]Annual air intake of 8.4×10^3 m^3/yr.
[c]Includes decay of ^{241}Pu to ^{241}Am for 50 years plus other plutonium isotopes.

Doses for transuranics were estimated as the product of the estimated average airborne ^{239}Pu concentrations for each stratum, a standard average breathing rate of 23 m^3 day (from Ref. D17), continuous occupancy, and the dose factors. These results are summarized in Table D-VIII by stratum for ^{239}Pu and total transuranics including ^{239}Pu. Doses estimated for ^{90}Sr and ^{137}Cs are also shown in Table D-VIII. They are the products of the estimated resuspended air concentration attributable to soil contamination, the breathing rate, and the appropriate dose factor.

In the case of some air sampling data being available, the measured average for 10 months on Chupadera Mesa is 41 aCi/m^3 (Ref. D14), while the estimated resuspension by calculation is 120 aCi/m^3. The estimated doses from inhalation are likely to be an overestimate.

B. Ingestion of Radionuclides

Dose calculations for ingested radionuclides considered the land use limitations of the areas of interest. Cattle grazing is the only land use out to the far fallout area. Beyond Chupadera Mesa, a few scattered fields of dry land wheat is raised, but the major land use is still cattle grazing. For the dose estimates here, the present land use assumes that all meat consumed, all milk products, and one-half the produce and vegetables are raised in the area being considered. The meat is further assumed to be all beef. Feed for the beef is assumed to be be by grazing or forage raised in the area of interest. The food intakes used are those listed in Table D-IX for the average individual. Other parameters used for the estimation of transfer of radionuclides through the food chain to man are listed in Table D-IX. Based on the feed crops available per unit area, the doses calculated for the inner fenced area and the area between fences at GZ are overestimates. Not all of the food assumed to be consumed could be produced in the area available without altering present land use practices. The dose factors used for the calculations are listed in Table D-X.

1. Produce, Vegetables, and Forage. The transfer of radionuclides from soil to plants was estimated using the soil concentrations measured for the fallout areas in 1974 and 1977 listed in Tables XIV through XIX in Chapter 4. The GZ data for 1983 were used for plutonium isotopes. The plant transfer parameters used for $^{239-240}Pu$ were measured for GZ and Chupadera Mesa (Ref. D20). The concentration ratio (CR) between plant and soils was used for calculations at GZ and the White Sands Missile Range fallout area. The measured $^{239-240}Pu$ CR for Chupadera Mesa was used for the other fallout areas. The CRs listed in Table D-X were used to calculate estimated radionuclide intake by beef and milk cows from forage and grazing. The produce and vegetable uptakes of radionuclides were estimated from the wet weight transfer parameter, B_v, and reduced 50% for removal of soils by washing. Estimated yearly radionuclide intakes from 50% locally grown produce and vegetables are listed in Table D-XI.

2. Beef and Milk Pathways. To estimate the amount of radionuclide intake by cattle, both the radionuclide transfer from soil to plant and direct consumption of soil were used.

TABLE D-VIII

ESTIMATED DOSES FROM INHALATION OF AIRBORNE MATERIALS FROM RESUSPENSION

Dose Calculated for	Inhalation Dose in Area of Interest (mrem)						
	Trinity Site Inner Fenced Area	Trinity Site Outer Fenced Area	White Sands Missile Range	Bingham	Chupadera Mesa	Far Fallout Zone	San Antonio
Transuranics							
First Year Residence							
Whole body	7.3×10^{-5}	1.9×10^{-6}	4.2×10^{-5}	1.3×10^{-5}	2.3×10^{-4}	4.2×10^{-5}	1.4×10^{-6}
Bone	2.6×10^{-3}	7.0×10^{-4}	1.5×10^{-3}	5.0×10^{-4}	8.4×10^{-3}	1.5×10^{-3}	5.1×10^{-5}
Lung	1.2×10^{-2}	4.4×10^{-3}	9.8×10^{-3}	3.0×10^{-3}	5.3×10^{-2}	9.8×10^{-3}	3.0×10^{-4}
50-Year Committed Dose							
Whole body	2.8×10^{-2}	07.3×10^{-3}	1.6×10^{-2}	4.9×10^{-3}	8.8×20^{-2}	1.6×10^{-2}	5.0×10^{-4}
Bone	0.29	7.4×10^{-2}	0.17	5.1×10^{-2}	0.91	0.17	5.5×10^{-3}
Lung	0.30	7.7×10^{-2}	0.17	5.3×10^{-2}	0.95	0.17	5.8×10^{-3}
Liver	0.14	3.7×10^{-2}	8.3×10^{-2}	2.5×10^{-2}	0.45	8.3×10^{-2}	2.8×10^{-3}
^{90}Sr							
First Year Residence							
Whole body	---	---	2.1×10^{-7}	---	6.1×10^{-6}	3.9×10^{-6}	---
Bone	---	---	3.1×10^{-6}	---	8.9×10^{-5}	5.6×10^{-5}	---
Lung	---	---	1.8×10^{-5}	---	5.0×10^{-4}	3.0×10^{-4}	---
50-Year Committed Dose							
Whole body	---	---	2.0×10^{-5}	---	6.0×10^{-4}	4.0×10^{-4}	---
Bone	---	---	3.1×10^{-4}	---	8.9×10^{-3}	5.6×10^{-3}	---
Lung	---	---	3.1×10^{-5}	---	8.9×10^{-4}	5.6×10^{-4}	---
^{137}Cs							
First Year Residence							
Whole body	7.8×10^{-6}	2.5×10^{-7}	5.0×10^{-7}	1.9×10^{-5}	3.0×10^{-5}	2.1×10^{-5}	5.0×10^{-5}
Bone	7.8×10^{-6}	2.5×10^{-7}	5.0×10^{-7}	1.9×10^{-5}	3.0×10^{-5}	2.1×10^{-5}	5.0×10^{-5}
Lung	1.2×10^{-6}	4.0×20^{-8}	7.9×10^{-8}	3.0×10^{-6}	4.8×10^{-6}	3.4×10^{-6}	7.8×10^{-6}
50-Year Committed Dose							
Whole body	1.3×10^{-5}	4.3×10^{-7}	8.5×10^{-7}	3.2×10^{-5}	5.2×10^{-5}	3.6×10^{-5}	8.5×10^{-5}
Bone	1.4×10^{-5}	4.3×10^{-7}	8.5×10^{-7}	3.2×10^{-5}	5.2×10^{-5}	3.6×10^{-5}	8.5×10^{-5}
Lung	2.2×10^{-6}	7.2×10^{-8}	1.4×10^{-7}	5.4×10^{-6}	8.7×10^{-6}	6.1×10^{-6}	1.4×10^{-5}
Totals for Inhalation							
First Year Residence							
Whole body	8.1×10^{-5}	1.9×10^{-5}	4.3×10^{-5}	3.2×10^{-5}	2.3×10^{-4}	6.7×10^{-5}	5.1×10^{-5}
Bone	2.6×10^{-3}	7.0×10^{-4}	1.5×10^{-3}	5.2×10^{-4}	8.4×10^{-3}	1.5×10^{-3}	1.0×10^{-4}
Lung	1.7×10^{-2}	4.4×10^{-3}	9.8×10^{-3}	3.0×10^{-3}	5.3×10^{-2}	1.0×10^{-2}	3.0×10^{-4}
50-Year Committed Dose							
Whole body	2.8×10^{-2}	7.3×10^{-3}	1.6×10^{-2}	4.9×10^{-3}	8.8×10^{-2}	1.6×10^{-2}	5.8×10^{-4}
Bone	0.29	7.4×10^{-2}	0.17	5.1×10^{-2}	0.91	0.17	5.6×10^{-3}
Lung	0.30	7.7×10^{-2}	0.17	5.3×10^{-2}	0.95	0.17	5.8×10^{-3}
Liver	0.14	3.7×10^{-2}	8.3×10^{-2}	2.5×10^{-2}	0.45	8.3×10^{-2}	2.8×10^{-3}

--- means no data.

TABLE D-IX

INPUT PARAMETERS FOR DOSE CALCULATIONS[a]

Breathing Rate	22.8 m^3/day			(Ref. D18)
Ingestion Rates	**Max Individual**	**Population**	(Average Individual)	(Refs. D21, D22)
Produce (kg/yr)	520	176		
Leafy vegetables (kg/yr)	64	18		
Milk (ℓ/yr)	310	112		
Average Agricultural Productivity per Unit Area	**Chupadera**	**Other**		
Feed crops (kg/m^2) (dry weight)	0.043	0.056		
Produce or leafy vegetables for garden of maximum exposed individual (kg/m^2) (wet weight)	2.0	2.0		(Ref. D22)
Consumption rate of feed by animal (kg/day) (dry weight)	11.9[b]	11.9[b]		(Ref. 23)
Fraction of radioactivity removed from plant by washing	0.5	0.5		(Ref. D24)
Soil ingested by cattle	250	250		(Ref. D25)

	Radionuclides					
	Plutonium					
Transfer Parameters[c]	**GZ**	**Chupadera**	**Strontium**	**Cesium**	**Europium**	
F_m	1.0×10^{-7}	1.0×10^{-7}	1.4×10^{-3}	7.1×10^{-3}	2.0×10^{-5}	(Ref. D26)
F_f	1.0×10^{-6}	1.0×10^{-6}	3.0×10^{-4}	2.0×10^{-2}	5.0×10^{-1}	(Ref. D27)
CR[d]	5×10^{-2}	1.1×10^{0}	1.8×10^{0}	4.1×10^{-2}	2.1×10^{-2}	(Refs. D20, D28)
B_v	1.2×10^{-2}	2.7×10^{-1}	7.2×10^{-2}	5.0×10^{-3}	7.3×10^{-4}	(Refs. D20, D28)

[a]Ref. D29.
[b]Taken as 2.5% of body weight, where the average live weight of cattle at slaughter of 477 kg was used.
[c]F_M = fraction of each day's radionuclide intake appearing in each liter of milk, F_f = fraction of each day's radionuclide intake appearing in each kilogram of flesh, CR = concentration ratio for radionuclide uptake from soil to pasture or feed (pCi/kg dry weight per pCi/kg dry soil), and B_v = concentration ratio for radionuclide uptake from soil to edible parts of vegetable crops (pCi/kg wet weight per pCi/kg dry soil).
[d]Plutonium CR based on measurements by Hakonson.

Experiments at contaminated zones of the Nevada Test Site have indicated that cattle ingest about 250 g/d of soil while grazing (Ref. D24). Transfer of the radionuclides from the cattle's diet into milk and meat were estimated using the factors lited in Table D-X. Estimates of the amount of radionuclides consumed yearly by humans in meat and milk are listed by area in Table D-XI.

3. Dose Estimates from Ingestion. The total intakes of $^{139,240}Pu$, ^{90}Sr, ^{137}Cs, and ^{152}Eu from consumption of beef, milk, and home garden products are listed in Table D-XI. The product of these values and the dose factors in Table D-X provide the maximum year dose and the 50-year committed dose equivalent for whole body, bone, liver, and the lower large intestine. The results of these calculations are listed in Table D-XII.

C. Special Pathways

The above dose estimates assume human activities that do not create any special considerations of sources of radionuclide intake. However, to grow 50% of their produce and vegetables, individuals would have to go through soil preparation activities. Measurements made during soil preparation activities indicate higher resuspension rates than normally encountered (Ref. D30). To estimate the dose to the home gardener requires some broad assumptions regarding breathing rate, suspended particle concentration, enrichment factor, dose factors, and appropriate soil concentration. The breathing rate used for this type of work was 43 ℓ/min, or that for heavy work (Ref. D17). Air concentrations were assumed to be 10 mg/m^3, the threshold for nuisance dust. Enrichment factors from Table D-VI were used. Soil concentrations used are the mean values of the summary data for 0-5, 5-10, and 10-15-cm soil samples in Chapter 4. The soil preparation time was assumed to be 30 h for a growing season. The parameters used are presented in Table D-XIII and estimated doses in Table D-XIV.

TABLE D-X

INGESTION DOSE FACTORS USED

Radionuclide	Maximum Year Dose [(mrem/yr)(pCi)/g soil)][a]		50-Year Committed Dose Equivalent (mrem/pCi)			
	Whole Body	Bone	Whole Body	Bone	Liver	GI-LLI
Plutonium isotopes[b]	c	0.45	c	7.8×10^{-4}	3.4×10^{-4}	c
^{90}Sr[d]	c	5	9.45×10^{-5}	1.17×10^{-3}	5.7×10^{-5}	7.78×10^{-5}
^{137}Cs[d]	0.63	c	4.91×10^{-5}	6.82×10^{-5}	7.87×10^{-5}	2.59×10^{-5}
^{152}Eu[d]	---	---	3.9×10^{-8}	2.0×10^{-7}	4.4×10^{-8}	2.6×10^{-5}

[a]Reference D30.
[b]Includes decay of ^{241}Pu to ^{241}Am after 50 years.
[c]Not calculated.
[d]Reference D31 and D32 for 50-year Committed Dose factors.

TABLE D-XI

INGESTED RADIONUCLIDES (pCi/yr)[a]

Radionuclide and Medium	Area of Interest						
	Trinity Site Inner Fence	Trinity Site Between Fences	White Sands Missile Range	Bingham	Chupadera Mesa	Far Fallout Zone	San Antonio
Transuranics							
Produce and vegetables[b]	9.1×10^4	3.4×10^3	5.8×10^3	4.6×10^3	2.2×10^4	3.9×10^3	1.3×10^2
Milk	1.46	0.055	0.095	0.052	0.25	0.045	0.0055
Beef	12.2	0.46	0.79	0.44	2.12	0.38	0.012
Total intake	9.1×10^4	3.4×10^3	5.8×10^3	4.6×10^3	2.2×10^4	3.9×10^3	1.3×10^2
^{90}Sr							
Produce and Vegetables[b]	c	c	6.3×10^3	c	8.0×10^3	5.2×10^3	c
Milk	c	c	6.1×10^3	c	7.8×10^3	5.1×10^3	c
Beef	c	c	1.10×10^3	c	1.4×10^3	9.2×10^2	c
Total intake	c	c	1.3×10^4	c	1.7×10^4	1.1×10^4	c
^{137}Cs							
Produce and vegetables[b]	5.3×10^3	1.6×10^2	1.1×10^3	9.0×10^2	6.8×10^2	4.8×10^2	2.2×10^2
Milk	1.3×10^4	3.8×10^2	2.6×10^3	2.2×10^3	1.6×10^3	1.2×10^3	5.4×10^2
Beef	3.1×10^4	8.9×10^2	6.2×10^3	5.1×10^3	3.9×10^3	2.8×10^3	1.3×10^3
Total intake	4.9×10^4	1.4×10^3	9.9×10^3	8.2×10^3	6.2×10^3	4.5×10^3	2.1×10^3
^{152}Eu							
Produce and vegetables[b]	8.7×10^3	7.1×10^2	1.9×10^2	c	1.1	c	c
Milk	2.7×10^2	2.2×10^1	6.0	c	0.034	c	c
Beef	8.6×10^3	7.1×10^2	1.9×10^2	c	1.1	c	c
Total intake	1.7×10^4	1.4×10^3	3.8×10^2	c	2.2	c	c

[a]Estimated for average individual in population.

[b]Fifty per cent of produce and vegetables are grown locally in gardens.

[c]Not calculated because no soil data were available.

TABLE D-XII

ESTIMATED DOSES FROM INGESTION OF FOODS GROWN IN EACH AREA

Dose Calculated	Ingestion Dose in Area of Interest (mrem/yr)						
	Trinity Site Inner Fence	Trinity Site Outer Fence	White Sands Missile Range	Bingham	Chupadera Mesa	Far Fallout Zone	San Antonio
Transuranics							
Maximum year							
Bone	70	2.6	4.5	3.6	17	3.0	0.1
50-Year Committed Dose							
Whole body	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Bone	71	2.6	4.5	3.6	17	3.0	0.1
Liver	31	1.2	2.0	1.6	7.5	1.3	0.04
GI-LLI[b]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
^{90}Sr							
Maximum Year							
Bone	[a]	[a]	9	9[c]	11.5	7.5	[a]
50-Year Committed Dose							
Whole body	[a]	[a]	1.2	1.2[c]	1.6	1.0	[a]
Bone	[a]	[a]	15	15[c]	20	13	[a]
Liver	[a]	[a]	0.07	0.07[c]	0.09	0.06	[a]
GI-LLI	[a]	[a]	1.0	1.0[c]	1.3	0.9	[a]
^{137}Cs							
Maximum Year							
Whole body	14	0.4	2.8	2.3	1.8	1.3	0.6
50-Year Committed Dose							
Whole body	2.4	0.1	0.5	0.4	0.3	0.2	0.1
Bone	3.4	0.1	0.7	0.6	0.4	0.3	0.1
Liver	3.8	0.1	0.8	0.6	0.5	0.4	0.2
GI-LLI	1.3	0.03	0.3	0.2	0.2	0.1	0.05
^{152}Eu							
50-Year Committed Dose							
Whole body	7×10^{-4}	5×10^{-5}	1×10^{-5}	9	[a]	[a]	[a]
Bone	3×10^{-3}	3×10^{-4}	8×10^{-5}	[a]	[a]	[a]	[a]
Liver	7×10^{-4}	6×10^{-5}	2×10^{-5}	[a]	[a]	[a]	[a]
GI-LLI	0.4	4×10^{-2}	[a]	[a]	[a]	[a]	[a]
Totals for Ingestion							
Maximum Year							
Whole body	14	0.4	2.8	2.3	1.8	1.3	0.6
Bone	--	---	13.5	---	28	11	---
50-Year Committed Dose							
Whole body	2.4	0.1	1.7	1.6	1.9	1.2	0.1
Bone	74	2.7	20	19	37	16	0.2
Liver	35	1.3	2.9	2.3	8.1	1.8	0.2
GI-LLI	1.3	0.03	1.3	1.2	1.5	1.0	0.05

[a]Not calculated.

[b]Gastrointestinal tract—large intestine.

[c]No measurements for Bingham for ^{90}Sr, so doses are assumed to be equal to those for White Sands Missile Range.

TABLE D-XIII

ESTIMATED AIR CONCENTRATION FOR SOIL PREPARATION FOR HOME GARDEN[a]

Area	Effective Soil Concentration (pCi/g)				Air Concentrations (μCi/m³)		
	$^{239-240}$	^{90}Sr	^{137}Cs	$\Sigma g_i f_i$	$^{239-240}$Pu	^{90}Sr	^{137}Cs
GZ							
Inner fence	24 ± 0.4	---	12.6 ± 2.5	0.071	1.7×10^{-8}	c	8.9×10^{-9}
Between fences	3.5 ± 3.3	---	0.4 ± 0.25	0.071	2.5×10^{-9}	c	2.83×10^{-10}
White Sands Missile Range	15 ± 12	0.96 ± 0.74	3.4 ± 2.2	0.071	1.1×10^{-8}	6.8×10^{-10}	2.4×10^{-9}
Bingham[b]	0.74 ± 0.49	---	0.25 ± 0.09	0.78	5.8×10^{-9}	c	2.0×10^{-9}
Chupadera Mesa	0.73 ± 0.85	1.5 ± 1.1	1.0 ± 1.5	1.6	1.2×10^{-8}	2.4×10^{-8}	1.6×10^{-8}
Far Fallout Field	0.15 ± 0.15	1.3 ± 0.9	0.75 ± 1.1	1.6	2.4×10^{-9}	2.1×10^{-8}	1.2×10^{-8}

[a]Dust loading of 10 000 μg/m³.
[b]Estimated from area measurements.
[c]Not calculated.

TABLE D-XIV

ESTIMATE DOSES FROM SOIL PREPARATION FOR HOME GARDEN[a]

50-Yr Committed Doses for	Inhalation Dose (mrem/yr)					
	GZ Inner Fence	GZ Between Fences	White Sands Missile Range	Bingham	Chupadera Mesa	Far Fallout Zone
Transuranics						
Whole body	0.11	0.017	0.073	0.039	0.082	0.016
Bone	1.2	0.17	0.76	0.40	0.84	0;17
Lung	1.2	0.18	0.80	0.42	0.87	0.17
Liver	0.59	0.086	0.38	0.20	0.42	0.084
^{90}Sr						
Whole body	[b]	[b]	4.0×10^{-5}	[b]	1.4×10^{-3}	1.2×10^{-3}
Bone	[b]	[b]	6.0×10^{-4}	[b]	2.2×10^{-2}	2.0×10^{-2}
Lung	[b]	[b]	6.3×10^{-5}	[b]	2.2×10^{-3}	2.0×10^{-3}
^{137}Cs						
Whole body	3.8×10^{-5}	1.2×10^{-6}	1.0×10^{-5}	8.7×10^{-6}	6.9×10^{-5}	5.2×10^{-5}
Bone	4.2×10^{-5}	1.3×10^{-6}	1.1×10^{-5}	9.4×10^{-6}	7.5×10^{-5}	5.7×10^{-5}
Lung	6.5×10^{-6}	2.0×10^{-7}	1.7×10^{-6}	1.4×10^{-6}	1.1×10^{-5}	8.7×10^{-6}
Totals						
Whole body	0.11	0.017	0.073	0.039	0.083	0.017
Bone	1.2	0.17	0.76	0.40	0.86	0.19
Lung	1.2	0.18	0.80	0.42	0.87	0.17
Liver	0.59	0.086	0.38	0.20	0.42	0.086

[a]Assumptions are breathing rate of 43 ℓ/min for 30 h/yr.
[b]Not calculated.

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APPENDIX E

SOURCES AND EVALUATION OF RADIATION EXPOSURES

I. INTRODUCTION

This appendix provides additional background on some of the technical aspects of radiation and its effects. It will familiarize the interested reader with the concepts and terminology used in the evaluations presented in the main body of this report and other appendixes. It is not comprehensive in that other concepts and terminology applicable to other circumstances are not included. A short bibliography is included at the end for those desiring to read further.

II. RADIATION

Radiation is the transmission of energy through space. There are many kinds of radiation including visible light, microwaves, radio and radar waves, and x rays. All of these are electromagnetic radiations because they consist of a combined electrical and a magnetic impulse traveling through space. Much of this radiation is vital to us. For example, light is necessary so that we can see. These radiations can also be harmful: too much ultraviolet radiation from the sun can cause sunburn or even skin cancer on prolonged exposure. Energy can also be transmitted through space by particulate radiations by virtue of their motion. Some of the most common particulate radiations include alpha particles, beta particles, and neutrons. The first two were given names of the first letters of the Greek alphabet by their discoverers as a convenient way of designating them. It turns out that the beta particle is an electron. The ***electron*** is the fundamental negative charge in all matter and is responsible for electric currents. However, ***beta particles*** are electrons moving at very high speeds, even approaching the speed of light. The other particulate radiations are also fundamental particles from atoms.

The class of radiation important to this report is ***ionizing radiation.*** Ionizing radiations are either waves or particles with sufficient energy to knock electrons out of the atoms or molecules in matter. This disruption is termed "ionization."

The simplest example is the ionization of a single atom. The ***nucleus,*** or center of the atom, is composed of particles called protons and neutrons. The ***proton*** has a positive charge and the ***neutron*** has no charge. Negatively charged particles called electrons orbit around the nucleus and are held in place by the attraction between the positive and negative charges. A simple analogy to this is the planets in orbit around the sun held in place by gravitational attraction. In a neutral atom there are exactly the same number of electrons as protons and the positive and negative charges are balanced. When ionizing radiation knocks an electron out of an atom, the atom is left with a positive charge, and the free electron is negatively charged. These two are referred to as an "ion pair." ***Ion pairs*** are chemically active and will react with neighboring atoms or molecules. The resulting chemical reactions are responsible for causing changes or damage to matter, including living tissue.

This brief description covers the basic concepts of radiation and its effects. The rest of the discussion will elaborate on particular aspects: the types and sources of ionizing radiation, the basic units for measuring energy deposited in matter by ionization, ways to estimate the amount of biological effect and its significance, and the nature of radiation standards.

III. TYPES OF IONIZING RADIATION

The most common types of ionizing radiation are x rays, gamma rays, alpha particles, beta particles, and neutrons.

A. X and Gamma Radiation

X rays are pure energy having no mass. They are part of the electromagnetic spectrum, as are light and microwaves, but with much shorter wavelengths and, therefore,

the ability to transmit larger amounts of energy. ***Gamma rays*** are identical to x rays except that they originate in the nucleus of an atom, whereas x rays are produced by interactions of electrons. An x or gamma ray, having no electrical charge to attract or repel it from the protons or electrons, can pass through the free space in many atoms and, hence, through relatively thick materials before interacting. The most likely interaction occurs when the x or gamma ray encounters an electron. When this occurs, some or all of the energy of the x or gamma ray will be transferred to the electron, which then will be ejected from the atom. The electron may have enough energy that it can, in turn, produce additional ionizations in other atoms it passes through. The electron, once its energy is spent, becomes a free electron (an electron not directly associated with an atom) like those found in all matter.

B. Alpha Radiation

Alpha particles are made up of two neutrons and two protons. This combination is the same as the nucleus of a helium atom. Because of the two protons, with no negative electrons to balance their positive charge, the alpha particle is positively charged. Alpha particles transmit energy as kinetic energy, or the energy of motion. The faster they move, the more energy they carry.

The comparatively large size and the positive charge of an alpha particle mean that it interacts readily with electrons and will not slip through the spaces between the atoms easily. It causes many ionizations in a short distance of travel. Because each of these ionizations dissipates energy, the alpha particle travels only a very short distance. For example, most alpha particles will not pass through a piece of paper or the protective layer of a person's skin. However, if an alpha particle is produced by radioactive material inside the body, it may cause many ionizations in more sensitive tissue.

C. Beta Radiation

Beta particles are electrons moving at high speeds. They transmit energy as kinetic energy. High-energy electrons approach the speed of light. They have comparatively small mass and a negative charge, so their penetration through matter is intermediate between the alpha particle and the gamma ray. They produce fewer ionizations along their path than the alpha particle, but more than gamma radiation. They can be absorbed by a sheet of rigid plastic or a piece of plywood. However, they can pass through the protective outer layer of the skin and reach the more sensitive skin cells in lower layers. They can irradiate internal tissues if produced by radioactive materials inside the body.

D. Neutrons

Neutrons are the particles that, with protons, form the nuclei of atoms. When free from the nucleus, they can transmit energy as kinetic energy. There are two major types of neutrons, fast and slow. Fast neutrons are moving rapidly and, when they strike a nucleus of an atom, they will give up some of their energy. With heavy nuclei such as those of lead, little energy is lost because the neutron rebounds. However, with light nuclei, such as those of hydrogen (hydrogen has one proton with the same mass as a neutron), the neutron undergoes a "billiard ball" type of collision with considerable energy transferred to the proton. The proton then moves through surrounding matter, producing less ionization than an alpha particle but more than a beta particle.

Slow neutrons do not have enough energy to cause ionization. But, because they have no charge, they can penetrate into the nucleus of an atom. This disrupts the balance in the nucleus and can result in the emission of radiations that produce ionization in the surrounding matter. One example of this is the transmutation of certain atoms of uranium into atoms of plutonium.

IV. SOURCES OF RADIATION

Radiation arises from radioactivity, both natural and manmade, cosmic sources, and radiation-producing machines. In this report, the sources of interest include cosmic radiation and natural radioactivity, which both contribute to normal background, and manmade or technologically enhanced radioactivity, which contribute radiation in addition to background. This report does not address the production of radiation by devices such as x-ray machines or accelerators.

A. Radioactivity

The atoms of most familiar things are structurally the same as when they were formed and have little prospect of changing. Thus, most atoms of carbon in a tree or in our bodies will remain atoms of carbon. In time, an atom may change its association with other atoms in chemical

reactions and become part of other compounds, but it will still be a carbon atom.

There is a class of atoms, however, which are not stable and will spontaneously emit radiation and change to another type of atom or element. These atoms are said to be ***radioactive.***

Many radioactive atoms such as isotopes of uranium and radium, ^{40}K. (potassium-40), and ^{14}C (carbon-14) occur naturally. In the cases of potassium and carbon, only certain proportions of the naturally occurring elements are radioactive and are known as ***radioactive isotopes.*** (The radioactive isotopes have the same number of protons in the nucleus as do the stable isotopes and, therefore the same chemical properties. However, the radioactive isotopes have a different number of neutrons than the stable atoms. A particular radioactive isotope is symbolized by the letter symbol for the chemical element with a numerical superscript representing the total number of protons and neutrons in the nucleus. See Table E-I for the symbols and names of isotopes of concern in this report.)

Many radioactive atoms can also be "manmade" in the sense that ^{137}Cs, ^{90}Sr, and radioactive isotopes of plutonium can be produced in large quantities during nuclear fission of uranium in a reactor. However, these isotopes are also produced during the normal spontaneous fissioning of uranium in nature. The difference is that in nature the reaction happens at a slow enough rate that the number of naturally produced radioactive atoms of cesium, strontium, and plutonium is small and dispersed. Other manmade radioactive elements produced in nuclear reactors or by accelerators are not normally present in nature.

Radioactive atoms attempt to achieve a more stable state by spontaneously ***decaying*** to alter the ratio of protons and neutrons in the nucleus toward a more stable condition.

Radioactive atoms decay at a characteristic rate dependent upon the degree of stability of the individual atom. The rate is characterized by a period of time called the ***half-life.*** In one half-life, one-half of the initial number of atoms decay. The amount of radiation emitted also decreases by one-half in the same period. In the next half-life, the number of atoms and the amount of radiation will again decrease by one-half, down to one-quarter of the original amount. Half-lives are unique for each particular type of radioactive atom: that is, each isotope has its own half-life that cannot be changed by man. Half-lives for different radioactive materials range from a fraction of a second to billions of years. In fact, some are so long that certain radioactive materials made at the time of the formation of the universe are still around. Examples include some isotopes of thorium and uranium.

When an atom decays, radiation may be emitted from the nucleus as alpha particles, beta particles, neutrons, or gamma rays. This changes the character of the nucleus, and the atom changes to an atom of a new element. (One particular type of decay, known as fission, results in the production of two new atoms.) Each type of radioactive atom decays with emission of characteristic types of radiation, each carrying specific amounts of energy. For example, natural ^{234}U always emits alpha particles with energies of about 4.8 relative energy units, and manmade ^{239}Pu emits alpha particles with energies of about 5.1 relative energy units. Other than the slight difference in the initial amount of energy, the alpha particles are indistinguishable.

Atoms resulting from radioactive decay are called "daughter" atoms, whereas the original atom is called the "parent" atom. In some cases, the daughter atom resulting from the decay of a radioactive atom is, itself, radioactive. For naturally occurring uranium and thorium, there may be a sequence of as many as 12-14 radioactive daughters before the original uranium or thorium atom finally reaches stability as an atom of lead.

Table E-I lists the radioactive materials of primary importance to this report giving the half-lives and the principal types of radiation they emit during decay.

B. Cosmic Radiation

The high-energy radiations that enter the earth's atmosphere from outer space are known as ***primary cosmic rays.*** The origin of primary cosmic rays is still not completely determined, but most of the observed radiation originates in our galaxy. Some is produced by solar flares. Primary galactic cosmic rays are largely high-energy protons. Primary solar cosmic rays have relatively low energy and have little effect at the earth's surface.

When primary cosmic ray particles enter the atmosphere, a complex variety of reactions occur, especially with oxygen and nitrogen nuclei. These reactions result in the continuous production of radioactive elements including tritium, ^{7}Be, ^{14}C, and ^{22}Na among many others. The reactions also result in the production of neutron and beta particle radiation, referred to as secondary cosmic radiation. The amount of radioactivity

TABLE E-I

RADIOACTIVE MATERIALS OF PRIMARY INTEREST
IN THE RADIOLOGICAL SURVEY

Isotope	Approximate Half-Life	Principal Types of Radiation
Natural Radioactivity of Interest as Background		
^{234}U (Uranium-234)	247 000 years	alpha, gamma
^{235}U (Uranium-235)	710 000 000 years	alpha, beta, gamma
^{238}U (Uranium-238)	4 500 000 000 years	alpha, beta, gamma
^{232}Th (Thorium-232)	14 100 000 000 years	alpha
^{226}Ra (Radium-226)	1 600 years	alpha, gamma
^{222}Rn (Radon-222)	3.8 days	alpha, gamma
^{40}K (Potassium-40)	1 300 000 000 years	beta, gamma
Radioactivity of Interest as Residual Contaminants or Worldwide Fallout from Atmospheric Testing		
^{239}Pu (Plutonium-239)	24 000 years	alpha, gamma
^{238}Pu (Plutonium-238)	87 years	alpha, gamma
^{241}Pu (Plutonium-241)	15 years	beta
^{241}Am (Americium-241)	458 years	alpha, gamma
^{137}Cs (Cesium-137)	30 years	beta, gamma
^{90}Sr (Strontium-90)	28 years	beta
^{3}H (Hydrogen-3 or Tritium)	13 years	beta
Uranium and radium as given above		

and radiation from cosmic rays increases significantly with altitude above sea level because of the decreasing thickness of the atmosphere. The influence of the earth's magnetic field results in more cosmic radiation in polar latitudes responsible for the so-called northern and southern lights.

V. UNITS FOR RADIATION AND RADIOACTIVITY

Units to quantify radiation or radioactivity provide for uniformity in measurements or comparisons and permit the establishment of standards specifying the amount of radiation allowable under various circumstances. Radiation units may initially seem obscure and difficult to understand. However, as in the case of the pound or kilogram, familiarity with the units makes them understandable and useful.

A. Radiation Units

The basic unit for measuring radiation is the ***rad.*** It is the amount of radiation that deposits a specified amount of energy by ionization in each gram of material (about 1/28 of an ounce). The amount of energy released in the material is small; it increases the temperature of the gram of material by a few billionths of a degree. However, it is not the amount of heat liberated or the temperature rise that is important. Rather, it is the ionization that induces chemical changes. The rad applies to all radiations and all materials that absorb the radiation.

The most commonly used radiation unit is the ***rem***. The rem quantifies the biological response to radiation rather than the amount of energy delivered to the tissue. To understand this, remember that different types of radiation produce ionizations at different rates as they pass through tissue. The alpha particle travels only a short distance, causing intense closely spaced ionization along its track. The beta particle travels much farther, causing much less ionization in each portion of its track. Therefore, the alpha particle is more damaging to tissue than the beta particle for the same number of ionizations because the damage to cells in the tissue is localized. The biological effectiveness of the alpha particle is greater than that of the beta particle for the same total amount (rads) of energy deposited, and this difference is accounted for by the use of appropriate factors. In general, the factors used are 1 for x or gamma radiations and most beta particles, 5 to 10 for neutrons, and 10 to 20 for alpha particles. The rem is defined as the amount of radiation (in rads) from a given type of radiation multiplied by the factor appropriate for that type of radiation to approximate the biological damage that it causes. Thus, 1 rad of energy from gamma rays would result in 1 rem, and 1 rad from alpha particles would result in 10 to 20 rem of dose. Because the approximate relative degree of damage from each of the types of radiation is known, the rem can be used to estimate the approximate biological effect. Within these limits of uncertainty, the rem permits evaluation of potential effects without regard to the type of radiation or its source. One rem of exposure from natural cosmic radiation results in the same biological consequences as 1 rem from medical x rays or 1 rem from radiation produced by decay of either natural or manmade radioactivity.

A frequent source of confusion encountered in the use of radiation units is their application to a standard weight of tissue, rather than all of the tissue irradiated. Thus, a person can receive 1 rad or 1 rem of radiation from an x ray of the teeth, where little tissue is irradiated; from a chest x ray, where a moderate amount of tissue is irradiated; or from full-body radiation, where all tissue in the body is irradiated. Although these are all 1 rem of radiation, the effects will be different depending upon the organs involved. Thus, one must always keep in mind the portion of the body or organs involved and make comparisons only for corresponding exposures. In this report, radiation doses were evaluated for the whole body, for the lungs, and for bone. Whole-body doses must be compared only with other whole-body doses or to whole-body dose standards, and so on.

Because many of the radiation doses discussed in this report were small, the metric prefixes ***milli*** for "one-thousandth" (1/1000 or 0.001, symbolized as "m") or as ***micro*** for "one-millionth" (1/1000 000 or 0.000001, symbolized "μ") were often used. One million microrem (μrem) = 1000 millirem (mrem) = 1 rem. Millirems are used exclusively in the rest of this appendix to simplify comparisons.

In some cases, radiation measurements are expressed as a dose rate, or the amount of radiation received in a unit of time. For example, some instrument measurements of background are reported in "microrem per hour" or μrem/h. To get total dose, the rate is multiplied by the time of exposure. This is conceptually similar to multiplying speed (rate of travel, say in miles per hour) by time to get total distance travelled.

Dose or ***dose rate*** may be expressed using rads or rems, depending on whether the reference is to energy deposited or to biological effect.

B. Radioactivity Units

The basic unit for measuring the amount of radioactivity or quantity of radioactive material is the ***curie***, named in honor of Madame Curie. The curie (Ci) is the amount of radioactive material in which 37 000 000 000 (37 billion) atoms are decaying each second. This apparently peculiar number is the approximate number of atoms decaying each second in 1 gram of pure radium, the element discovered by Madame Curie. The mass of material in a curie varies from one isotope to another. The different half-lives of each radioactive material are the main cause for this variation. For materials with short half-lives, a large fraction of the atoms present are decaying in any given second, and the weight of 1 curie is small. For radioactive materials with long half-lives, the weight of 1 curie will be large. For example, the weight of 1 curie of naturally occurring ^{40}K is about 310 pounds, or about 140 000 times as much as 1 curie of radium.

The curie is a relatively large quantity of radioactivity for most purposes of this report. Accordingly, the metric prefixes are used to indicate units in fractional parts of a curie, such as microcurie or picocurie. The units used most often in the report are summarized in Table E-II.

TABLE E-II

UNITS OF RADIOACTIVITY USED IN THE RADIOLOGICAL SURVEY

Unit	Abbreviation	Disintegrations per Second	Equivalent Value in Other Time Units
curie	Ci	37 000 000 000	---
millicurie	mCi	37 000 000	---
microcurie	μCi	37 000	---
picocurie	pCi	0.037	2.22 per minute
attocurie	aCi	0.000000037	1.2 per year

The text often discusses radioactivity in environmental media, such as air or soil. In these cases, radioactivity is reported as a ***concentration***, or the amount of radioactivity in or associated with a certain amount of air or soil. Much of the information on radioactivity in soils is reported as ***picocuries per gram*** (pCi/g) of some particular radioactive isotope. This means that there are a certain number of picocuries of the isotope associated with each gram (454 grams = 1 pound) of soil. For example, a value of 1 pCi/g means that each gram of soil has an associated radioactivity of about 2.2 decays each minute. Concentrations of radioactivity in air are generally reported as ***attocuries per cubic meter*** (aCi/m^3). This means that there are a certain number of attocuries of a radioactive isotope dispersed throughout the volume of air equivalent to a cube 1 meter on each side (1 meter = 1.09 yards). For example, a value of 3 aCi/m^3 would mean that a cubic meter of air contains radioactivity of about 3.6 decays in a year.

VI. DETERMINING HOW MUCH RADIATION IS RECEIVED

Radiation doses can be received from sources external to the body, such as cosmic radiation or radiation produced by radioactivity in the earth. Radiation doses can also be received from radiation produced by radioactivity taken into the body by inhalation or ingestion. These two modes of exposure are important in this study in terms of both normal doses from background radiation or radioactivity and incremental doses attributable to residual contaminants.

The important distinction between radiation and radioactivity must be emphasized at this time to avoid confusion. When radiation interacts with a person's body, it is quickly dissipated as ionization and eventually heat. However, radioactive materials can enter a person's body and remain there for some period of time, emitting radiation. Thus, it is incorrect to say that there is "radiation in a person's body." It is correct to say the person has radioactive materials in his body and radiation is emitted from these radioactive materials.

A. External Penetrating Radiation

Normal external penetrating radiation doses come primarily from natural terrestrial sources or natural cosmic sources. These doses affect the entire body, including all internal organs.

1. Natural Terrestrial Sources. The radioactivity in rocks, soils, and other natural materials arises primarily from three sources: uranium and its daughters (such as radium), thorium and its daughters, and potassium. There are many other natural radioactive materials, but their contributions to human dose are small. The amount of gamma radiation from these sources varies in different parts of the country depending upon the amounts of natural radioactivity in the soil. The average for the coastal plain is about 15 mrem per year; for the non-coastal plain, excluding the Colorado plateau area, it is about 30 mrem per year; and for the Colorado plateau area, it is about 60 mrem per year. There are, however, variations within these averages, with higher values in

given localities. For example, radiation up to 100 mrem per year from soils and rocks has been measured in central Florida and in the granitic regions of New England. In India and Brazil, terrestrial radiation reaches several hundred mrem per year over large regions and even higher values in smaller parts of these regions.

Measurements in the Los Alamos, New Mexico, area indicate an average of about 57 mrem per year from natural terrestrial sources. Because of the variety of geologic formations in the area, the range is from about 30 to 90 mrem per year. Thus, the average is about 40% higher than for the U.S., as a whole, but the range is less than for the U.S.

The same natural radioactive materials, especially uranium and thorium, are responsible for penetrating radiation doses from masonry structures. A United Nations study reports that doses average about 30% higher inside masonry structures than outdoors. Conversely, structures of wood or metal materials afford some shielding and may reduce indoor doses from natural terrestrial radioctivity by 25% compared with outdoor doses.

2. Natural Cosmic Sources. As previously discussed, cosmic radiation arises primarily from space outside of our solar system. The atmosphere provides some shielding, but there is a definite increase in cosmic ray intensity as one goes to higher altitudes. At sea level, cosmic rays, including cosmic neutrons, produce about 30 mrem a year. At the altitude of Denver, Colorado (5000 ft), they produce about 55 mrem per year, and at Leadville, Colorado (10 000 ft), they produce about 120 mrem per year.

Airline travel at higher altitudes can result in doses of 0.2 to 0.3 mrem per hour or 1.5 to 2 mrem total for a single transcontinental trip.

3. Medical Diagnostic X Rays and Other Manmade Radiation. People receive manmade radiation from a number of sources. By far, the most important are medical procedures, including diagnostic x rays and the medical use of radioactive isotopes. The average annual whole-body dose to a resident of the U.S. from diagnostic medical procedures is estimated at 70 to 90 mrem per year, or an amount about equal to normal background radiation.

Other sources of manmade or man-enhanced radiation, including television, smoke detectors, luminous-dial watches, mining and milling of phosphate, and burning coal and natural gas, add 2 to 5 mrem per year.

B. Radiation from Internally Deposited Radioactivity

Many radioactive materials, both natural and manmade, can be incorporated into tissues because their chemical properties are identical or similar to those of isotopes in the tissues. For example, 0.012% of natural potassium is the radioactive isotope ^{40}K. The radioactive portion of potassium is incorporated into plant and animal tissues in the same manner as the stable potassium isotopes because the chemical properties are identical. Radioactive ^{90}Sr, which results from nuclear fission, can be incorporated in tissues because its chemical behavior is similar to that of calcium. Once such radioactive isotopes are deposited in biological tissue, they emit radiation that results in an internal dose to the organ or organism. An important point is that internally deposited alpha emitters can be significant because the alpha particle radiation is emitted directly into tissue, whereas external alpha particle radiation is stopped by the outermost skin layers.

1. Pathways. Although radiation from internally deposited radioactive materials may cause the same ultimate effects as external penetrating radiation, the evaluation is more complex. This is because the physical and chemical processes that govern movements of the materials in nature and biological systems must be considered. The evaluation of movements of materials by such processes as dispersion in the atmosphere, transport in water, uptake in plants or animals, and ultimately, the biochemistry of the human body is often termed ***pathway analysis.*** There is nothing unique to pathway analysis of radioactive materials; the methods and principles are equally applicable to movements of natural substances and nonradioactive pollutants.

The major types of environmental pathway analyses considered in the radiological survey were resuspension, hydrologic transport, and food chains. These are all ways of transporting contaminants to the human body.

Resuspension encompasses various mechanisms, such as wind or mechanical disturbance, for making particles of dust and soil airborne. Once airborne, the particles and any contaminants on them are potentially available for inhalation.

Hydrologic transport encompasses movement of materials dissolved in water and movement of materials attached to sediments. Such movements can make contaminants available for ingestion with drinking water and uptake in plants or animals or can redistribute sediments to different locations.

Food chains encompass the movement of materials through natural biological systems. A typical sequence starts with plants taking up materials from soil or water during natural plant growth or gardening. The next step could be ingestion of plant materials by cattle or fish, followed by ingestion of beef or fish by humans.

Once environmental pathways have made materials available for entry into the human body, the analysis must determine how the substances of concern will be assimilated within the body. This requires an understanding of the complex biochemistry of the body to determine where particular substances will be deposited and how long they will be retained. For example, both strontium and plutonium can ultimately be preferentially deposited in bone and are then retained for long periods. However, the amount deposited depends strongly on the chemical form of the element and whether the materials gain entry by inhalation or ingestion. For the same amounts of radioactivity, strontium is deposited to a greater degree when ingested, and plutonium is deposited to a greater degree when inhaled.

Internally deposited radioactivity gives off radiation and thereby produces doses as long as it is in the body. Accordingly, doses delivered must be accounted for over a period of time beyond the period during which the radioactivity was ingested or inhaled.

The ***50-year dose commitments*** represent the total dose accumulated in the body or specific organs over a 50-year period because of ingestion or inhalation of radioactivity during the first year. The 50-year commitments are always as large as or larger than first-year doses. In this summary, only the 50-year commitments are compared with the standards.

Conceptually, this is in agreement with the recommendations of the International Commission on Radiological Protection (ICRP), and, in effect, for regulatory purposes charges the entire dose commitment against the year in which exposure occurs. The use of the 50-year dose commitment also permits making estimates of risk over a lifetime from the given exposure and simplifies comparisons between different exposure situations.

The dose commitments were calculated using published factors from references currently used in regulation. The mathematical dose models employed in the derivation of these factors were based primarily upon recommendations of the International Commission on Radiological Protection.

Other methods of computing doses are available, and some are considered more up-to-date in terms of utilizing the best current understanding of the behavior of isotopes within the body. Additionally, there are conceptually different approaches that emphasize the dose at the time of maximum dose rate following exposure as the basis for comparison with standards. This is significant for isotopes such as plutonium that accumulate in certain parts of the body and can lead to a constantly increasing dose rate under conditions of chronic exposure. One such approach has been proposed by the EPA as guidance for Federal agencies in regard to plutonium.

These other approaches do not result in dose estimates or comparisons with standards for the radionuclides of concern sufficiently different from the methods used in this report to make any significant difference in the conclusions drawn. For example, under conditions of chronic exposure to airborne ^{239}Pu, the dose in the year of maximum dose rate (taken to be the 70th year) calculated by alternate methods gave estimates ranging from about 1.4 (for bone) to 2.6 (for lung) times the 50-year dose commitment. These differences are of about the same magnitude as other uncertainties in field data and are smaller than some of the intentionally overestimated assumptions incorporated into these evaluation. Thus, there would be no significant changes in the relative ranking or general magnitude of estimated doses and risks if other methodologies were used.

2. **Radiation from Natural Radioactivity.** The most prominant internal natural radioactive material in the body is a radioactive isotope of potassium. Potassium-40 is distributed throughout the body and contributes about 17 mrem per year to the whole body. Other natural radioactivity taken in with food or air adds enough radiation to bring the total whole-body dose to about 27 mrem per year.

Some natural radioactive materials tend to concentrate in particular parts of the body. For example, radium and its daughters concentrate in bone and contribute a major part of the approximately 47-mrem-per-year bone dose.

Radon, a natural radioactive gas given off by all terrestrial materials including soil and masonry products, is the largest contributor to internal lung doses. Radon is inhaled with air and decays by alpha-particle radiation

through a chain of other radioactive daughters that contribute doses as they, in turn, decay. Concentrations of natural radon in the air can be greatly increased in masonry structures or in tightly sealed structures where dilution by ventilation air exchange is low.

3. Radiation from Worldwide Fallout Radioactivity. Radioactive materials released by atmospheric nuclear weapons testing have been dispersed worldwide and deposited on soils everywhere. By various pathways, including resuspension and food chains, small amounts of such radioactivity are incorporated into every human body. The average dose from worldwide fallout radioactivity to the population in the U.S. for the whole body is about 4.4 mrem a year. For lungs and bones, the doses are less than 1% of doses from natural materials.

VII. POTENTIAL HARM OR RISK FROM RADIATION

The damage done by radiation results from the way it affects molecules essential to the normal function of body cells. Four things may happen when radiation strikes a cell.

1. It may pass through the cell without doing any damage.

2. It may damage the cell, but the cell partially repairs the damage. (The ability of a cell to repair some of the damage from radiation explains why a given dose of radiation delivered in small amounts over a long period of time is generally believed to be less damaging than the same total dose given all at once.)

3. It may damage the cell so that the cell fails to repair itself and reproduces in damaged form over a period of years.

4. It may kill the cell.

The death of a single cell may not be harmful, but serious problems occur if so many cells are killed in a particular organ that the organ no longer can function properly. Incompletely or incorrectly repaired cells may, over a period of time, produce delayed health effects such as cancer, genetic mutations, or birth defects.

Radiation at high enough doses will kill in a short time. The lethal dose is estimated to be 400 000 to 500 000 mrem for gamma radiation with death occurring in 10-30 days. However, the public is seldom, if ever, subjected to such high doses. We will, therefore, concentrate our attention on the effects that occur later, cancer and genetic effects.

A. Cancer

Information on the induction of cancer in humans arises from several sources. The most important data on external radiation are for the Japanese who survived the blast effects but received radiation at Hiroshima and Nagasaki and for the people who were exposed to radiation during medical therapy. Information on internal emitters comes from the radium dial painters who ingested radium while painting dials in the early 1920s, from a group of patients who were administered radium as a tonic, and from uranium miners who were exposed to radon and its daughter products. Evaluations of such data have led to estimates of the likelihood of radiation-induced cancer. These estimates are accepted by the vast majority of scientists working nationally and internationally with radiation.

Before discussing the actual risks, there are several points that are fundamental in interpreting the values. First, cancers or genetic changes caused by radiation cannot be distinguished from those that are occurring every day spontaneously or caused by other carcinogenic chemicals. About 400 000 deaths occur from cancers in the U.S. each year, or about 15 to 20 per 10 000 people. We can infer an effect from radiation only if the total number of cancers (or of a particular type of cancer) is increased by an amount we can detect. Valid comparisons are made even more difficult because some population groups have higher normal rates of cancer than others. This may be due to differences in the way they live and the possible carcinogens in their environment. Cancer also occurs more often in older people than in younger people. Thus, to detect increases in effects, a comparison (or control) group that is the same as the exposed group is necessary.

This all leads to the fact that there have been no direct measurements of increased cancer for low-level radiation exposures (1000-5000 mrem). Data exist only for much higher exposures (100 000 mrem and above delivered in a short time). Thus, scientists have estimated risks for the lower doses by assuming that any dose results in some effect (no threshold for effect) and that the relation between the radiation dose and the effect (cancer) is linear. That is, for each doubling of the dose there will be

a doubling of the effect. This is an assumption that is generally believed to provide an overestimate of any effects. In fact, many scientists are now using a more complex mathematical relation between dose and effect that estimates risks at 2 to 10 times lower than the values given in this report.

Second, another characteristic of cancer or genetic effects from any cause is that they are statistical in nature. That is, not all of the individuals will be affected. Rather, a few individuals in the population will get cancer or have genetic defects and the remainder will not be affected. Therefore, we express the risk as the likely number of effects in a given population. For example, 30 cancers per million people means we expect 30 cancers out of this group of 1 000 000 people, but cannot tell which of the 30 will get cancer. Or, this example could also be stated that an average individual in that population has a risk of cancer of 30 chances in a million.

Cancers of many types can result from radiation or other carcinogens. These cancers do not occur for some period of time after exposure, usually 5 to 25 years. This period of time is called the latent period. For example, there is information from the Japanese survivors that the latent period for the first leukemia to appear is 1 to 4 years. The risk of leukemia is limited to about 25 years after the exposure. After this time, the risk of leukemia goes down to the normal incidence. For other cancers, the latent period is longer, about 10 to 20 years. However, information is incomplete.

Estimates have been made of the number of cancers that could result from a given radiation exposure, using the data for humans. These estimates generally are considered to be high because of the use of the linear, no-threshold assumption in extrapolating from the high levels at which people actually were exposed. In spite of this, these estimates are useful for illustrating the amount of additional cancer that could be induced in a population exposed to radiation (or conversely, the chance that an individual exposed to radiation will get cancer).

The estimates of health effects *risks* given in this report were based on the factors recommended by the National Academy of Science and the International Commission on Radiological Protection. Multiplying an estimated dose by the appropriate risk factor gives an estimate of the probability of injury to the individual as a result of that exposure. The risk factors used are

For uniform whole-body dose	
Cancer mortality	0.0000001 per mrem whole body,
For specific organ doses	
Lung cancer	0.0000002 per mrem to lung,
Bone cancer	0.000000005 per mrem to bone.

As an example, a whole-body dose of 10 mrem per year would be estimated to add a risk of cancer mortality to the exposed individual of one chance in a million (1/1 000 000) per year of exposure.

Such risk estimates must be placed in appropriate contexts to be useful as a decision-making tool. A useful comparison is an estimate of the risk that can be attributed to natural background radiation. Radiation from various natural external and internal sources results in exactly the same types of interactions with body tissues as that from so-called "manmade" radioactivity. Thus, the risks from a given dose are the same regardless of the source.

Natural background radiation for people in the Los Alamos, New Mexico, area consists of the external penetrating dose from cosmic and terrestrial sources, cosmic neutron radiation, and self-irradiation from natural isotopes in the body. These sources give a combined whole-body dose averaging about 158 mrem per year. This can be interpreted using the ICRP risk factors to represent a contribution to the risk of cancer mortality of 15 chances in a million for each year of exposure or a risk of 8 chances in 10 000 for 50 years of exposure to natural background radiation. As perspective, the overall U.S. population lifetime risk of mortality from cancer induced by all causes is currently estimated at about 2 chances in 10.

B. Genetic Effects

One of the concerns of many people is the possible effect of their exposure to radiation on future children. An effect on the reproductive cells of the body that can be inherited by children is called a genetic effect and the change itself is called a mutation. Many of these mutations are unnoticeable or barely noticeable.

There is no information based on human exposure that will allow an estimate of the risk of mutations. Thus, data from animals such as fruit flies and mice, along with known abnormalities in human births and general knowledge of genetics, have been used to arrive at an estimate of the risks. Careful study of the survivors of the Hiroshima and Nagasaki bombs and their descendents

has shown that these estimates are reasonable. The information available is not sufficient to provide a precise estimate, but a range of values will illustrate the magnitude of the risk.

About 10% of all births are estimated to have some form of genetic mutation. These range in importance from the trivial, such as a change in eye color, to the serious, such as a stillbirth or a deformity in the body of the child. Exposure to 1000 mrem of radiation during the childbearing years is estimated to result in 6 to 100 additional changes per million births in the first generation. This may be compared with the 100 000 estimated to occur in the same group without above-background radiation. Continued exposure to 1000 mrem for generation after generation is estimated to eventually lead to 10 to 150 additional births with genetic mutations per million births. If the actual radiation received is higher or lower, the numbers given above will change in proportion.

C. Effects on the Fetus

You will often see signs in the x-ray departments of hospitals asking women to see the doctor if they have reason to believe they are pregnant. The reason is that the fetus, particularly in the first three months, is especially sensitive to radiation and may be damaged if exposed to excessive radiation. The doctor, therefore, may wish to re-evaluate his procedure.

Animal information on single exposures to radiation indicates that some changes detectable by sophisticated tests have occurred with a few rems. At present, no specific relationship between dose and the likelihood of damage has been developed. Because of this and the relatively low doses attributable to residual contaminants, no estimates of effects were made in this report.

VIII. STANDARDS FOR EXPOSURE TO RADIATION

There are a number of organizations that provide standards or regulations governing the amount of radiation people should receive. Voluntary standards, or recommendations, are provided by the International Commission on Radiological Protection (ICRP) and the U.S. National Council on Radiation Protection and Measurements (NCRP). These are both groups of scientists knowledgeable about radiation who study the available data and recommend appropriate limitations on the maximum amount of exposure that should be received. They also make recommendations on appropriate equipment and procedures. Their recommendations are nonbinding but have been accepted by many of the regulatory agencies.

The principal regulatory agencies in the U.S., which provide regulations on radiation exposure, are the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). Other agencies that provide regulations in their own areas of interest include the Food and Drug Administration (FDA) and the Occupational Safety and Health Administration (OSHA).

The EPA is the lead agency in the sense that it provides basic guidance to be used by all Federal agencies. The EPA has the responsibility to provide general environmental standards for the Nuclear Regulatory Commission and specific responsibilities to produce standards under the Clean Air Act, the Clear Water Act, and the Resources Recovery and Conservation Act. The EPA has adopted a policy of setting standards at as low a level as is believed economically feasible. For this reason, the EPA standards are frequently lower than those from the ICRP or the NCRP.

The Nuclear Regulatory Commission provides regulations to cover nuclear reactors and all products associated with reactors, including the radioactive materials used for medicine. Because the Nuclear Regulatory Commission does not regulate natural radioactive materials or x rays, the states have taken responsibility, usually using the recommendations of the NCRP.

The standards and regulations, or guides, fall into two general categories: (1) the primary radiation protection standards and (2) the secondary standards for intake of radioactive materials. Within each category there are generally two sets of values, one applicable to occupationally exposed persons and the second applicable to members of the public. All comparisons in this report are made with the standards appropriate for the general public.

An important principle in all radiation protection recommendations and regulations is that the amount of radiation received by people should be kept as far below the actual dose limit as is reasonably achievable. That is, the goal of a radiation protection program is not to see that everyone is kept at or just below the limits; instead, the goal is to see that working conditions and practices

are such that both the workers and the public receive the smallest amount of radiation that can practically be achieved.

A. Primary Radiation Protection Standards

Primary radiation protection standards give limits for total exposure to external and internal radiation for the whole body or for specific organs. The standards, or upper limits, for the public are basically one-tenth of the values permitted for occupationally exposed workers. The standards apply to increments of exposure in addition to natural background and in addition to medical exposures.

The upper limit adopted by all Federal agencies, including the Department of Energy, for whole-body radiation to an individual member of the public is 500 millirem per year. For average radiation doses to an exposed population, the Federal Radiation Council (which has been incorporated into the EPA) recommended that the average exposure to that portion of the population receiving the highest annual dose be limited to 170 millirem in addition to natural or medical radiation exposure. (This average limit was set to minimize potential genetic damage and was derived from a limit of 5000 millirem over 30 years for large populations.)

The basic radiation standards as used by the Department of Energy are shown in Table E-III. These include both whole-body limits and specific organ limits. The EPA has proposed Federal guidance for exposure to transuranium elements, also shown in Table E-III.

A final word about these standards and their meaning is appropriate. Exposure to more radiation than permitted by the standards is not analogous to stepping off a cliff. That is, there is no sharp line between doses causing excessive harm and doses causing little or no harm. The opposite situation is true for many chemical poisons. An additional exposure of 1 millirem increases a person's risk to cancer or genetic mutation by the same amount whether it is a millirem of background radiation, the first millirem above background radiation, or the first millirem above the 500 millirem limit.

All of the doses evaluated in this radiological survey under current conditions of land use were small fractions of those permitted above natural background and medical exposure by the DOE Radiation Protection Standards. The highest dose, from the unlikely circumstance of a full-year occupancy of a small portion of the former waste treatment plant site, was estimated at about 12% of the standard. All other doses were less than 2% of the standard.

For projected possible land use conditions, the maximum dose estimates were for hypothetical home gardeners in one of the canyon areas (about 1.5% of the standard) and construction workers (about 6% of the standard). Continuous exposure to resuspended dust in the canyons was estimated to result in less than 1.3% of the EPA proposed guidance for persons exposed to transuranium elements in the general environment.

The various doses evaluated are summarized in Chapter 1 and described more completely in Chapter 5, Sections II and III.

B. Secondary Standards for Intake of Radioactive Materials

Secondary standards to be used in control of exposure by limiting the intake of radioactive materials are calculated from the primary standards using knowledge of the fate of the particular radioactive material in the body and the time it remains in individual organs. These standards are estimated for ingestion of water and inhalation of air. They are expressed as concentrations and are generally calculated so that the doses received from internal radioactivity will not exceed the primary standard under conditions of continuous exposure to the contaminants in air or water.

The assumption of continuous inhalation of air or ingestion of water, upon which the secondary limits are based, leads to a problem in their use. A frequent misinterpretation is that the secondary standards represent maximum concentrations to which a person can be exposed regardless of the time of exposure. This is not true. The total *intake* of radioactivity determines the dose received, not the particular concentration in air or water at any given time. The secondary standards are calculated as annual averages. Thus, a person could be exposed to 10 times the secondary standard concentration for a week and receive only about 20% of the annual intake permitted by the secondary standard.

The secondary standards account for the fact that some radioactive materials have a short half-life or are rapidly eliminated from the body. Tritium is eliminated from the body with a half-life of 12 to 1[illegible] days. Thus, the radiation received from a single drink at the secondary limit will be only a fraction of the annual limit that is calculated for continuous intake. Another example, plutonium, which is very well retained in the body and has a

TABLE E-III

STANDARDS AND GUIDES FOR RADIATION AND RADIOACTIVITY

DOE Radiation Protection Standards for External and Internal Exposures

Individuals and Population Groups in Uncontrolled Areas

Type of Exposure	Annual Dose Equivalent or Dose Commitment	
	Based on Dose to Individuals at Points of Maximum Probable Exposure	Based on an Average Dose to a Suitable Sample of the Exposed Population
Whole body, gonads, or bone marrow	0.5 rem (or 500 mrem)	0.17 rem (or 170 mrem)
Other organs	1.5 rem (or 1500 mrem)	0.5 mrem (or 500 mrem)

EPA Maximum Contaminant Levels from Natural
Interim Primary Drinking Water Regulation

Isotope	Media	Concentration
Gross Alpha (including ^{226}Ra but excluding radon and uranium)	Water	15 pCi/ℓ

long half-life, will reach the annual radiation limit only after continuous inhalation or ingestion at the secondary limits for 50 years. Thus, intake at or above this limit for days, weeks, or even months will not result in reaching or even approaching the primary standard dose limit.

The secondary standards are usually stated as concentrations of radioactivity in air or in water, as defined in Section V.B of this Appendix. The values used for comparison in this report are presented in Table E-III. The DOE secondary standards are called Concentration Guides. The EPA secondary standards for drinking water are called Maximum Contaminant Levels, and for airborne transuranics are called Derived Air Concentrations. None of the relevant secondary standards was exceeded by any measured or theoretically estimated concentrations. Evaluations in the radiological survey were carried through to estimates of doses to permit comparison with the primary standards. Accordingly, no emphasis was placed on comparisons with the secondary standards.

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